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Abstract

Overweight and obesity prevalence have increased dramatically over the past two decades. Further, national surveys have indicated that Canadian adolescents have sub-optimal nutritional intakes and low levels of physical activity. In order to provide a better understanding of the dietary and physical activity behaviours of Canadian youth, the purpose of this research was to explore the nutrition, physical activity and related health behaviours of a sample of adolescents in Alberta and Ontario, Canada. This was done with a comprehensive surveillance of behavioural variables using a novel web-based assessment tool. Further, in-school assessments (measured) and repeat web-based surveys (self-report) were examined to specifically investigate the reliability and validity of *Web-SPAN (Web-Survey of Physical Activity and Nutrition)*. On average, students were within the Acceptable Macronutrient Distribution Ranges for all macronutrients; however, micronutrient and fibre intakes were sub-optimal. Overall diet quality reflected the low adherence to Canada's Food Guide to Healthy Eating (CFGHE), and indicated that over 40% had poor diet quality. Macronutrient intakes and servings of Other Foods were significantly different between diet quality groups (based on CFGHE; poor, met 0-1; average, met 2-3; superior, met all 4 minimum food group recommendations) and between non-overweight, overweight and obese students (determined using the International Obesity Task Force cut-offs). Further, differences were observed between diet quality groups and weight status for physical activity and breakfast consumption. Improvements in physical activity and breakfast consumption were observed when diet quality increased, or weight status decreased. Students with poor diet quality consumed meals away from home more frequently than those with higher diet quality. Overall

correlations were good for reliability and validity of *Web-SPAN*. In conclusion, Alberta and Ontario adolescents were not meeting minimum CFGHE recommendations, and thus have sub-optimal micronutrient intakes and poor diet quality. Sub-optimal nutritional intakes, meal skipping, consuming meals away from home and physical inactivity were related to poor diet quality and weight status and reflect the need to target these health behaviours in order to improve overall health and wellness. The validation of various components of the web-based survey makes this tool an attractive, efficient and cost-effective method of data collection.

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List of Abbreviations

AI:	Adequate Intake
AMDR:	Acceptable Macronutrient Distribution Range
ANOVA:	Analysis of Variance
BIA:	Bioelectrical Impedance Analysis
BMI:	Body Mass Index
CAD:	Coronary Artery Disease
CCHS:	Canadian Community Health Survey
CDC:	Centers for Disease Control and Prevention
CFGHE:	Canada's Food Guide to Healthy Eating
CPAG:	Canada's Physical Activity Guide to Healthy Active Living
CVD:	Cardiovascular Disease
DPA:	Daily Physical Activity
DRI:	Dietary Reference Intake
DXA:	Dual Energy X-Ray Absorptiometry
EAR:	Estimated Average Requirement
EE:	Energy Expenditure
FFM:	Fat Free Mass
FFQ:	Food Frequency Questionnaire
FIRSSt:	Food Intake Recording Software System
HDL:	High-Density Lipoprotein
ICC:	Intraclass Correlation Coefficient
IOTF:	International Obesity Task Force

KKD:	Kilocalories per Kilogram of body weight
LDL:	Low-Density Lipoprotein
MANCOVA:	Multivariate Analysis of Co-variance
MAR:	Mean Adequacy Ratio
MET:	Metabolic Equivalent
NHANES:	National Health and Nutrition Examination Survey
NHES:	National Health Examination Survey
PAF:	Population Attributable Fractions
PAR:	Population Attributable Risks
PAQ-C:	Physical Activity Questionnaire for Older Children
RDA:	Recommended Dietary Allowance
RNI:	Recommended Nutrient Intake
TBW:	Total Body Water
20mSRT:	20-Meter Shuttle Run Test
UL:	Tolerable Upper Intake Level
WC:	Waist Circumference
Web-SPAN:	Web-Survey of Physical Activity and Nutrition

Definitions

DRI:	Dietary Reference Intake; a reference value that is a quantitative estimate of a nutrient intake. It is used for planning and assessing diets for healthy people. *Definition from Institute of Medicine (2000, p. 3)*
EAR:	Estimated Average Requirement; a nutrient intake estimated to meet the requirement of half the healthy individuals in a particular life stage and gender group. *Definition from Institute of Medicine (2000, p.3)*
RDA:	Recommended Dietary Allowance; the average daily intake level sufficient to meet the nutrient requirement of nearly all (97 to 98 percent) healthy individuals in a particular life stage and gender group. *Definition from Institute of Medicine (2000, p.3)*
AI:	Adequate Intake; a recommended average daily nutrient intake level based on observed or experimentally determined approximations or estimates of nutrient intake by a group (or groups) of apparently healthy people that are assumed to be adequate – used when an RDA cannot be determined. *Definition from Institute of Medicine (2000, p.3)*
UL:	Tolerable Upper Intake Level; the highest average daily nutrient intake level likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects increases. *Definition from Institute of Medicine (2000, p.3)*

Chapter 1: Introduction

1.1 Thesis Organization

This thesis has been prepared as a paper-format thesis according to specifications provided by the Faculty of Graduate Studies and Research at the University of Alberta. Following the introduction, Chapters 2 and 3 are included as literature reviews and Chapters 4, 5, 6 and 7 are included as individual manuscripts. A preface precedes Chapters 4, 5, 6 and 7 with a brief description of the study (database and methodology used). Chapters 4, 5, 6 and 7 are currently being prepared for submission to the following journals: *Canadian Journal of Dietetic Practice and Research* (Chapter 4), *Journal of the American Dietetic Association* (Chapter 5), *American Journal of Clinical Nutrition* (Chapter 6) and *International Journal of Obesity* (Chapter 7).

1.2 Rationale

The rising prevalence of overweight and obesity is an increasing concern among Canadian children and adolescents. Over the 25-year period from 1978/79 – 2004, prevalence of overweight significantly increased among boys (13 – 18%), and girls (12 – 18%). Increases in rates of obesity were even more dramatic, from 4 – 9% in boys and 3 – 7% in girls (Shields, 2005). The health impact of obesity is significant. Obese children and adolescents have increased prevalence of impaired glucose tolerance, dyslipidemia, hypertension, and type 2 diabetes (Ball & McCargar, 2003; Goran, Ball, & Cruz, 2003; Must & Strauss, 1999). Historically, type 2 diabetes was thought to occur only in adults; however, a new epidemic is emerging as type 2 diabetes is being diagnosed at younger ages, concurrent with increases in childhood and adolescent obesity (Brosnan, Upchurch,

& Schreiner, 2001). Additionally, obese adolescents are targets of discrimination, which can have lasting effects on self-image, often persisting into adulthood (Dietz, 1998).

Obesity has been shown to track into adulthood, especially among adolescents (Freedman et al., 2005; Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Guo, Wu, Chumlea, & Roche, 2002; Serdula et al., 1993; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Therefore, many overweight and obese adolescents become obese adults, at risk for numerous health problems, including type 2 diabetes, cardiovascular disease, hypertension, osteoarthritis, gallbladder disease, and some forms of cancer (Tjepkema, 2005). Given the significant health consequences associated with obesity, there is an enormous burden on the Canadian health care system. The direct health care costs associated with obesity were estimated at an excess of $1.8 billion in 1997 (2.4% of the total health care expenditures), with the largest contributors being hypertension, type 2 diabetes, and coronary artery disease (Birmingham, Muller, Palepu, Spinelli, & Anis, 1999). A more recent study estimated the independent economic burden of physical inactivity and obesity in 2001 at $5.3 billion for inactivity ($1.6 billion in direct costs and $3.7 billion in indirect costs) and $4.3 billion for obesity ($1.6 billion in direct costs and $2.7 billion in indirect costs) (Katzmarzyk & Janssen, 2004).

Obesity is a complex condition involving individual/behavioural, environmental and social factors, however it has been proposed that a basic imbalance of energy intake and energy expenditure leads to increased adiposity (Ruvession & Tataranni, 1997). Specifically, individual behaviours such as increased consumption of high calorie foods, decreased physical activity, and increased sedentary activity have been identified as key issues in the development of obesity (Shields, 2005). Although it is widely accepted that physical activity has decreased among the adolescent population, there is conflicting evidence regarding changes in nutrient intakes, which could potentially be explained by methodological differences. Several researchers have suggested that an increase in dietary fat intake, not dietary energy intake can be correlated to an increase in body fat in children ages 4 to 11 years (Gazzaniga & Burns, 1993; Maffeis, Pinelli, & Schutz, 1996; Nguyen, Larson, Johnson, & Goran, 1996; Obarzanek et al., 1994; Tucker, Seljaas, & Hager, 1997), while Gillis and colleagues (2002) demonstrated a stronger effect between dietary energy intake and obesity among children and adolescents. Further, an additional study showed a decrease in dietary fat intake and little change in energy intake despite an increase in the prevalence of overweight (Troiano, Briefel, Carroll, & Bialostosky, 2000).

Although there are numerous health implications of obesity, there is limited combined data on the nutrition and physical activity status of Canadian youth. Further, many studies conducted outside Canada have shown inconsistencies in regards to the significance of nutritional intake in the development of obesity. Adolescents are at a life stage where they have increased autonomy regarding nutrition, physical activity, and other health behaviours. Many of the decisions and choices adolescents make may persist into adulthood and have lasting impact on long term health (Dietz, 1998). Thus, it can be stated that a better understanding of the overall dietary and physical activity behaviours of Canadian youth will provide important information for development of programs to help decrease the risk of overweight or obesity in adolescents, which may prevent youth from developing chronic diseases in the future.

1.3 Purpose

The overall purpose of this cross-sectional research was to explore the nutrition, physical activity and related eating behaviours of a sample of adolescents in Alberta and Ontario. This was done with a comprehensive surveillance of behavioural variables using a novel web-based assessment tool.

1.4 Research Questions

The research questions for thesis were as follows:

1. What is the nutritional status (micronutrient, macronutrient, food group) of a sample of Alberta and Ontario boys and girls that participated in a web-based survey?
2. Do adolescents with poor diet quality have different macronutrient and Other Food group intakes, and different meal behaviours and physical activity levels when compared to their peers with average or superior diet quality?
3. What is the physical activity status of a sample of Alberta boys and girls that participated in a web-based survey?
4. Do non-overweight adolescents have different macronutrient and Other Food group intakes, and different meal behaviours and physical activity levels when compared to their overweight or obese peers?

5. **Is the Web-Survey of Physical Activity and Nutrition (Web-SPAN) a reliable and valid tool to assess nutrition and physical activity behaviours in a sample of Alberta adolescents?**

1.5 Hypotheses

The primary hypotheses of this thesis were as follows:

Hypothesis 1: In a sample of Canadian adolescents:

- **a.** Acceptable Macronutrient Distribution Ranges will be consistent with recommendations **(Chapter 4, 6).**
- **b.** fibre and adjusted average intakes of key micronutrients[*] will be inconsistent with recommendations **(Chapter 4, 6).**
- **c.** median food group intakes will be below recommendations **(Chapter 4, 6).**
- **d.** boys will have higher energy, macronutrient and food group intakes than girls **(Chapter 4, 6).**

Hypothesis 2: Using a measure of diet quality[†] based on Canada's Food Guide to Healthy Eating, Canadian adolescents with average or superior diet quality, compared to those with poor diet quality will have:

- **a.** significantly different macronutrient intakes, where those with average or superior diet quality will have higher intakes of fibre and lower intakes of fat compared to those with poor diet quality **(Chapter 4, 6).**
- **b.** significantly lower intakes of foods from the Other Foods sub-categories **(Chapter 4, 6).**

---

[*] Vitamin A, vitamin C, iron, niacin, zinc, calcium, vitamin D (key micronutrients for optimal nutritional intakes)

[†] Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations.

c. significantly lower frequency of sub-optimal meal behaviours including meal skipping and consuming meals away from home **(Chapter 4, 6)**.

d. significantly higher levels of physical activity **(Chapter 6)**.

Hypothesis 3: In a sample of Alberta junior and senior high school students:

a. the majority of students will have low levels of physical activity **(Chapter 6)**.

b. girls will have lower levels of physical activity than boys **(Chapter 6)**.

c. older students will have lower levels of physical activity than younger students **(Chapter 6)**.

Hypothesis 4: In a sample of Alberta junior and senior high school students, non-overweight[‡] students compared to overweight or obese students will have:

a. significantly different macronutrient intakes **(Chapter 7)**.

b. significantly lower intakes of foods from the Other Foods sub-categories **(Chapter 7)**.

c. significantly higher diet quality[†] as based on Canada's Food Guide to Healthy Eating **(Chapter 7)**.

d. significantly lower frequency of sub-optimal meal behaviours including meal skipping and consuming meals away from home **(Chapter 7)**.

[‡] Non-overweight refers to all non-overweight, non-obese students

[†] Diet Quality: poor, met 0-1 food group recommendations; average, met 1-3 food group recommendations; superior, met all four food group recommendations.

Hypothesis 5: In a sample of Alberta junior and senior high school students, non-overweight[‡] students compared to overweight or obese students will have higher levels of physical activity **(Chapter 7)**.

a. Non-overweight[‡] boys will have higher levels of physical activity than overweight or obese boys **(Chapter 7)**.

b. Non-overweight[‡] girls will have higher levels of physical activity than overweight or obese girls **(Chapter 7)**.

[‡] Non-overweight refers to all non-overweight, non-obese students

1.6 Objectives

In order to test these hypotheses, the objectives were as follows:

Objective 1: On-line self-reported 24-hour dietary recall data from a sample of Canadian adolescents were used:

- **a.** to describe intakes of total energy (kcals), by gender **(Chapter 4, 6)**.
- **b.** to describe intakes of carbohydrates, protein, fat, fibre and key micronutrients[*], by gender, relative to recommendations (Dietary Reference Intakes) **(Chapter 4, 6)**.
- **c.** to describe intakes based on food groups of Canada's Food Guide to Healthy Eating, by gender, relative to recommendations **(Chapter 4, 6)**.

Objective 2: On-line self-reported 24-hour dietary recall data from a sample of Canadian adolescents were used to describe differences between students with poor, average and superior diet quality[†] in terms of:

- **a.** intakes of carbohydrates, protein, fat and fibre **(Chapter 4, 6)**.
- **b.** intakes of Other Foods sub-categories (foods containing mostly sugar, high salt/fat, high calorie beverages, low calorie beverages, or high sugar/fat) according to Canada's Food Guide to Healthy Eating **(Chapter 4, 6)**.

---

[*] Vitamin A, vitamin C, iron, niacin, zinc, calcium, vitamin D (key micronutrients for optimal nutritional intakes)

[†] Diet Quality: poor, met 0-1 food group recommendations; average, met 1-3 food group recommendations; superior, met all four food group recommendations.

c. sub-optimal meal behaviours (frequency of meal skipping, frequency of consuming meals prepared away from home) **(Chapter 4, 6)**.

Objective 3: Two on-line self reported height and weight measurements, measured height and weight, waist circumference and bioelectrical impedance analysis (BIA) were used:

a. to determine test-retest reliability of the on-line self-reported height and weight measurements **(Chapter 5).**

b. to measure concurrent validity of self-reported height and weight with measured height and weight **(Chapter 5).**

c. to determine prevalence of overweight and obesity using self-reported height and weight and measured height and weight **(Chapter 5).**

d. to determine prevalence of youth at risk for developing obesity-related disorders using waist circumference **(Appendix E).**

e. to determine percent body fat using BIA **(Appendix E).**

Objective 4: Two on-line self-reported non-consecutive 24-hour dietary recalls and a 3-day food record were used:

a. to examine repeat comparisons of the on-line 24-hour dietary recall **(Chapter 5).**

b. to measure concurrent validity of the on-line 24-hour dietary recall compared to food records **(Chapter 5).**

Objective 5: In order to assess the reliability and validity of the physical activity section of the web-based survey, two on-line self-reported PAQ-Cs, a 3-day pedometer record, guided self-administered Physical Activity Questionnaire for Older Children (PAQ-C) and a 20-metre shuttle run test were used:

a. to determine test-retest reliability of the on-line PAQ-C **(Chapter 5).**

b. to measure parallel-forms reliability of the on-line PAQ-C compared to the guided self-administered PAQ-C **(Chapter 5).**

c. to measure convergent validity between the on-line PAQ-C and the 20-metre shuttle run test and 3-day pedometer record **(Chapter 5).**

Objective 6: On-line self-reported survey data (PAQ-C) from Alberta students in grade seven through 10 were used to describe physical activity levels, by gender and age **(Chapter 6).**

Objective 7: On-line self-reported survey data (24-hour dietary recall, PAQ-C, and height and weight) from Alberta students in grade seven through 10 were used to describe differences between non-overweight[‡], overweight and obese students in terms of:

a. intakes of carbohydrates, protein, fat and fibre **(Chapter 7).**

b. intakes of Other Foods sub-categories (foods containing mostly sugar, high salt/fat, high calorie beverages, low calorie beverages, or high sugar/fat) according to Canada's Food Guide to Healthy Eating **(Chapter 7)**.

[‡] Non-overweight refers to all non-overweight, non-obese students

c. sub-optimal meal behaviours (frequency of meal skipping, frequency of consuming meals prepared away from home) **(Chapter 7).**

d. diet quality[†] (poor, average, and superior) **(Chapter 7)**.

e. physical activity levels, by gender **(Chapter 7).**

[†] Diet Quality: poor, met 0-1 food group recommendations; average, met 1-3 food group recommendations; superior, met all four food group recommendations.

1.7 References

Ball, G. D. C., & McCargar, L. J. (2003). Childhood obesity in Canada: a review of prevalence estimates and risk factors for cardiovascular diseases and type 2 diabetes. *Canadian Journal of Applied Physiology, 28*(1), 117-140.

Birmingham, C. L., Muller, J. L., Palepu, A., Spinelli, J. J., & Anis, A. H. (1999). The cost of obesity in Canada. *Canadian Medical Association Journal, 160*(4), 483-488.

Brosnan, C. A., Upchurch, S., & Schreiner, B. (2001). Type 2 diabetes in children and adolescents: An emerging disease. *Journal of Pediatric Health Care, 15*(4), 187-193.

Dietz, W. H. (1998). Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics, 101*(3), 518-525.

Freedman, D. S., Khan, L. K., Serdula, M. K., Dietz, W. H., Srinivasan, S. R., & Berenson, G. S. (2005). The relation of childhood BMI to adult adiposity: the Bogalusa Heart Study. *Pediatrics, 115*(1), 22-27.

Gazzaniga, J. M., & Burns, T. L. (1993). Relationship between diet composition and body fatness, with adjustment for resting energy expenditure and physical activity, in preadolescent children. *American Journal of Clinical Nutrition, 58*, 21-28.

Gillis, L. J., Kennedy, L. C., Gillis, A. M., & Bar-Or, O. (2002). Relationship between juvenile obesity, dietary energy and fat intake and physical activity. *International Journal of Obesity, 26*, 458-463.

Goran, M. I., Ball, G. D. C., & Cruz, M. L. (2003). Obesity and risk of type 2 diabetes and cardiovascular disease in children and adolescents. *Journal of Clinical Endocrinology & Metabolism, 88*(4), 1417-1427.

Guo, S. S., Roche, A. F., Chumlea, W. C., Gardner, J. D., & Siervogel, R. M. (1994). The predictive value of childhood body mass index values for overweight at age 35 y. *American Journal of Clinical Nutrition, 59*, 810-819.

Guo, S. S., Wu, W., Chumlea, W. C., & Roche, A. F. (2002). Predicting overweight and obesity in adulthood from body mass index values in childhood and adolescence. *American Journal of Clinical Nutrition, 76*(3), 653-658.

Katzmarzyk, P. T., & Janssen, I. (2004). The economic costs associated with physical inactivity and obesity in Canada: an update. *Canadian Journal of Applied Physiology, 29*(1), 90-115.

Maffeis, C., Pinelli, L., & Schutz, Y. (1996). Fat intake and adiposity in 8 to 11-year-old obese children. *International Journal of Obesity and Related Metabolic Disorders, 20*(2), 170-174.

Must, A., & Strauss, R. S. (1999). Risks and consequences of childhood and adolescent obesity. *International Journal of Obesity and Related Metabolic Disorders, 23 Suppl 2*, S2-S11.

Nguyen, V. T., Larson, D. E., Johnson, R. K., & Goran, M. I. (1996). Fat intake and adiposity in children of lean and obese parents. *American Journal of Clinical Nutrition, 63*, 507-513.

Obarzanek, E., Schreiber, G. B., Crawford, P. B., Goldman, S. R., Barrier, P. M., Frederick, M. M., & Lakatos, E. (1994). Energy intake and physical activity in relation to indexes of body fat: the National Heart, Lung, and Blood Institute Growth and Health Study. *American Journal of Clinical Nutrition, 60*, 15-22.

Ruvession, R., & Tataranni, P. A. (1997). Dietary fat and human obesity. *Journal of the American Dietetic Association, 97*, S42-S46.

Serdula, M. K., Ivery, D., Coates, R. J., Freedman, D. S., Williamson, D. F., & Byers, T. (1993). Do obese children become obese adults? A review of the literature. *Preventive Medicine, 22*(2), 167-177.

Shields, M. (2005). Measured obesity: Overweight Canadian children and adolescents [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/2005001/pdf/cobesity.pdf.

Tjepkema, M. (2005). Measured obesity: Adult obesity in Canada [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/2005001/pdf/aobesity.pdf.

Troiano, R. P., Briefel, R. R., Carroll, M. D., & Bialostosky, K. (2000). Energy and fat intakes of children and adolescents in the United States: Data from the National Health and Nutrition Examination surveys. *American Journal of Clinical Nutrition, 72*(5 Suppl), 1343S-1353S.

Tucker, L. A., Seljaas, G. T., & Hager, R. L. (1997). Body fat percentage of children varies according to their diet composition. *Journal of the American Dietetic Association, 97*(9), 981-986.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *The New England Journal of Medicine, 337*(13), 869-873.

Chapter 2: Literature Review of Adolescent Nutrition and Physical Activity Status and Related Assessment Methodologies

2.1 Introduction

Nutrition and physical activity are important determinants of obesity; however there is limited knowledge of the health of Canadian adolescents in regards to these two behaviours. Prior to the 2004 Canadian Community Health Survey (CCHS), eating habits had not been measured in a nationally representative sample of all Canadians since the early 1970s (1970 – 1972 Nutrition Canada Survey). Furthermore, it is difficult to establish secular trends in nutritional intake, as assessment methodologies often differ between surveys. Additional data from the Food Habits of Canadians study provides some insight; however like many other studies of adolescents, it was limited by a small sample size (Jacobs Starkey, Johnson-Down, & Gray-Donald, 2001). Data on physical activity is more prevalent, with assessments completed in the 2004 CCHS in addition to previous cycles of the Canadian Community Health Survey along with the earlier Canada Fitness Survey and the Campbell's Survey of Well Being. This literature review will discuss assessment methodologies used to measure diet, activity, and anthropometry as well as the nutrition and physical activity status of Canadian adolescents.

2.2 Assessment Methodologies

Assessment methodologies used to evaluate dietary intake, physical activity, physical fitness, and anthropometry will be reviewed in the following section. Methods will be described in terms of relevance to the adolescent population and the strengths, limitations and overall implications of using each method.

2.2.1 Nutritional Intake

There are many different methods used to assess dietary intake. Two methods, the 24-hour dietary recall and the food record, are intended to measure what is actually consumed over a pre-determined amount of time. The food-frequency questionnaire (FFQ) measures an individual's perception of their own intake over an estimated period of time. However, all methods rely on the ability of the individual to accurately recall items consumed. Even when using food records, individuals frequently postpone recording items until after the meal is consumed and therefore may not be able to accurately recall their intake. Both the researcher (interviewer) and the research participant (interviewee) must be properly trained in areas such as portion sizes, cooking/preparation methods, and the detail needed in order to accurately assess an individual's diet.

Like adults, many adolescents experience recall bias, response bias, and underreporting of total energy intake (Bandini et al., 2003; Livingstone et al., 1992). Although adolescents have increased cognitive ability to record or remember their intakes compared to younger children (Baranowski & Domel, 1994), they are also more independent and have increased consumption of foods away from home. This can cause increases in random error of the dietary data, which can lead to increased variance of the measure. The resulting effects of random error can be reduced by either increasing the number of days of observation or by increasing the number of research participants (Rutishauser, 2005).

Each method of dietary assessment has relative strengths and limitations, and techniques. Subject burden, training, measurement error and population-specific barriers are all important considerations that must be evaluated before selecting a method of dietary assessment. In the following sections, the 24-hour recall, food record, and food frequency questionnaire will be discussed.

2.2.1.1 24-hour Dietary Recall

A 24-hour dietary recall is a recall of all foods and beverages consumed in the previous day, and is generally conducted by a trained dietary interviewer. The 24-hour recall method is one of the most widely used methods to assess dietary intake because it allows an open-ended approach to collecting intake data. There is no limit to the amount of foods, combinations of foods, cooking methods and other detailed information that can be provided to the interviewer. In addition, this method does not require literacy and also has less subject burden compared to other methods. However, the accuracy of this method is dependent on the memory of the interviewee. The 24-hour recall method generally utilizes a chronological format, meaning the interview begins with listing the first thing the respondent consumed the previous day (food item, description of the item, and amount). More recently, a multiple-pass 24-hour recall was developed by the U.S. Department of Agriculture – Human Nutrition Information Service to help decrease the amount of underreporting in dietary recalls (Guenther, DeMaio, Ingwersen, & Berline, 1995). This method improves reporting by providing cues throughout the process that guides the subject through the interview. This is in contrast to the traditional 24-hour recall which is completed using three distinct passes. In the first pass the respondent provides a list of all foods they consumed the previous day in the order the respondent prefers (not necessarily in chronological order). Then a detailed list of the foods is obtained (e.g., type of spread used on toast), and the respondent is asked about any additional foods that may have been previously omitted (i.e., beverages). The third pass provides the respondent an opportunity to review the recall in order to ensure all information is accurate. This pass also allows another opportunity to add foods or beverages. Furthermore, food models are often used to assist respondents in selecting the appropriate portion size of the items consumed the previous day.

Utilizing three multiple-pass 24-hour recalls, Johnson et al. (1996) compared reported energy intake to total measured energy expenditure using doubly labeled water in a sample of 24 children (ages 4 – 7 years). Over the 14-day period, there was no statistical difference between 3-day mean energy intake (1,553 kcals/day) and total energy expenditure (1,607 kcals/day). The authors concluded that the multiple-pass method was a valid and practical method that could be used to assess dietary intake without placing a high level of burden on subjects (Johnson et al., 1996).

Although the 24-hour dietary recall is traditionally completed by a trained interviewer, other web-based methods have been established to collect dietary intake data. The University of Waterloo web-based dietary assessment tool (Food Behaviour Questionnaire; 24-hour recall) was validated using dietitian-administered 24-hour dietary recalls. In a sample of grade 6 through 8 Ontario students (n = 51), the web-based recall was compared to a traditional dietitian-administered recall over the same 24-hour period. In comparison to the dietitian-administered recall, the web-based assessment provided good agreement (intraclass correlation coefficients (ICC); Pearson ρ) for total caloric intake (ICC = 0.66; ρ = 0.70), carbohydrates (ICC = 0.65; ρ = 0.66), protein (ICC = 0.51; ρ = 0.55), fat (ICC = 0.66; ρ = 0.71), fibre (ICC = 0.68; ρ = 0.69) and key micronutrients (ICC = 0.47 to 0.78; ρ = 0.51 to 0.83) (Hanning & Health Behaviour Research Group, 2004). In comparison to direct observation of food items selected at lunch hour versus those selected on the web-survey, grade 9 and 10 students (n = 15) showed an overall agreement of 87% (Hanning et al., 2004).

Because the web-based 24-hour dietary recall is not facilitated by a trained interviewer, cues to promote cognitive processes must be included on the website. Portion size images and reminders of beverage intake are provided in addition to various topping screens which, for example, remind the respondents to select the type and amount of milk they may have had with their cereal, or the spread that was added to toast. Additional visual cues such as a meal plate filling up as selections are made and a meal summary provide another opportunity to add or delete items from the recall therefore improving the accuracy of the 24-hour recall.

Although 24-hour dietary recalls provide mean estimates of population intake, usual intake cannot be determined using a one-day measure. Food intake varies between individuals as well as within individuals, thus it is essential to separate inter-individual from intra-individual variation. In order to do this, however, multiple days of intake data are required (Barr, 2006). Software programs such as Software for Intake Distribution Estimation (PC-SIDE) developed by Nusser et al. (1996) can be used to adjust for intra-individual variation therefore producing estimates of usual intake. Recently, the CCHS conducted 24-hour dietary recalls in a representative sample of 35,107 Canadian children, adolescents and adults and subsequently used the SIDE software to assess nutritional status (Garriguet, 2004). This demonstrates the utility of the PC-SIDE method in large cross-sectional studies and is therefore appropriate for the research presented in this thesis.

2.2.1.2 Food Records

Food records are another method of assessing dietary intake, and are generally considered the gold standard in dietary assessment (Rockett & Colditz, 1997). Subjects keep detailed dietary records for a period of one or more days, and therefore must be trained and motivated to successfully complete the record. Although food records do not rely on memory, they do require literacy. In school-aged adolescents this is generally not a concern; however it is an issue that must be considered when determining the utility of this dietary assessment method.

As part of the National Heart, Lung and Blood Institute Growth and Health Study of 2,379 girls, Crawford et al. (1994) examined the intakes of 58 girls ages 9 to 10 years using observation in addition to either a 24-hour recall, 5-day food frequency questionnaire, or 3-day food record. The best agreement (Spearman correlations) between reported and observed intakes was with the 3-day food record (0.86), followed by 24-hour recall (0.62), and the 5-day food frequency questionnaire (0.32). However, out of all three assessment methods, the 3-day food record was the most time consuming to complete, resulting in a higher subject burden.

Although the food record is considered the gold standard, errors and bias often occur. To reduce error, it is important that the participants are trained using verbal and written instructions on record keeping, portion sizes, food preparation methods and consuming meals away from home. It is also necessary to instruct the participants to continue usual eating habits throughout the measurement period. Subjects are often affected by social desirability, where they feel the need to provide others with a favourable impression of oneself (Brener, Billy, & Grady, 2003). This can lead to intentional omission of foods deemed socially unacceptable, or "unhealthy", by the subject. Additional error can be linked to a lack of motivation of the subject. Because of the high subject burden during transcription of foods, individuals may choose to reduce intake in order to decrease the amount of effort required to complete a food record (Willett, 1998). Although in this situation the food record accurately reflects what is being consumed, it is not representative of usual intake. All of these issues should be reiterated during the instruction period and throughout data collection. To further reduce error, food records should be reviewed with a trained dietary interviewer immediately after data collection. The interviewer can check for completeness and provide cues to remind the participant of any foods or beverages mistakenly omitted (Willett, 1998).

2.2.1.3 Food Frequency Questionnaire

Due to the expense and methodological issues surrounding usual intake when utilizing 24-hour dietary recalls and food records, food frequency questionnaires (FFQ) are often used. A FFQ allows researchers to collect data on long term dietary intake data that generally would not be feasible using the two previous methods. The typical FFQ contains a list of foods with options for choosing the appropriate frequency of consumption of each food. Food lists vary from only a few foods to over a hundred foods as determined by the researcher. Generally, FFQs do not allow for open-ended responses; however an exception would be questionnaires that contain information on portion sizes. Since FFQs are almost always self-reported intake, they are very practical in epidemiologic applications.

Although FFQs are an attractive method to assess usual intake, special considerations must be taken for children and adolescents. Prior to the development of the semi-quantitative youth/adolescent questionnaire (YAQ) by Rockett et al. (1995), there was limited research on the reliability and validity of FFQ used in children and adolescents. The YAQ provided an age-specific reproducible (Rockett et al., 1995) and valid ($r = 0.54$; compared to three 24-hour recalls) measurement for youth ages 9 to 18 years (Rockett et al., 1997). Further, the authors have used this method to assess changes in nutrient intake over a one-year period in 10,769 youth ages 9 to 14 years. In another study involving 109 fourth to seventh grade students, the FFQ was shown to provide better estimates of various nutrients in sixth and seventh grade students (Pearson correlation coefficients ranged from 0.07 to 0.76) in comparison to fourth and fifth grade students (Pearson correlation coefficients ranged from 0.02 to 0.42) (Field et al., 1999). Thus, it can be stated that the cognitive ability of the participants must be taken into consideration before selecting a FFQ as the primary dietary assessment method. Due to the lower subject burden and ability to adapt the 24-hour recall to web-based methodology, the 24-hour recall was chosen as the most appropriate method of assessing dietary intake for the research presented in this thesis.

2.2.2 Physical Activity and Physical Fitness

Although the terms physical activity and physical fitness are often used interchangeably, they have very different meanings. “Physical activity is any bodily movement produced by skeletal muscles that results in energy expenditure” (Caspersen, Powell, & Christenson, 1985, p. 126; Centers for Disease Control and Prevention, 2006b, para. 16) which can include activities such as walking, running, or household activities such as cleaning and yard work. Physical fitness refers to “a set of attributes a person has in regards to a person's ability to perform physical activities that require aerobic fitness, endurance, strength, or flexibility and is determined by a combination of regular activity and genetically inherited ability” (Centers for Disease Control and Prevention, 2006b, para. 17). Methods used to assess physical activity (Physical Activity Questionnaire for Older Children, pedometer records) and physical fitness (20-metre shuttle run test) will be discussed.

2.2.2.1 Physical Activity Questionnaire for Older Children (PAQ-C)

The Physical Activity Questionnaire for Older Children (PAQ-C) is a guided self-administered questionnaire used to assess physical activity levels over a seven-day period. The PAQ-C was specifically designed for school-aged youth, and includes components on physical activity during the school day as well as after school and weekend activity. Most importantly, the questionnaire was developed in Canada, thus the content reflects typical activities that are appropriate for Canadian youth (Kowalski, Crocker, & Donen, 2004).

In response to a need for a reliable and valid tool that could be used in large research studies within the childhood/adolescent population, Crocker et al. (1997) developed the PAQ-C to assess moderate to vigorous physical activity. The questionnaire consists of 10 items, of which 9 are used to calculate an activity score. The activity score creates a ceiling of scores which helps to prevent outliers and gives researchers the ability to differentiate between high and low active children. Within the PAQ-C, time related memory cues using a segmented day procedure (e.g., recess, lunch, after-school, evening, weekday and weekend) were built in to improve recall as described by Baranowski (1988). The PAQ-C was found to be a reliable method to assess physical activity when test-retest reliability was examined over a period of one week in 84 boys (r = 0.75) and girls (r = 0.82) ages 9 to 14 years (Crocker et al., 1997). Furthermore, the PAQ-C was found to be a valid measure in 9 to 14 year olds (n = 97) when compared to other physical activity and fitness assessment methods including an activity rating (r = 0.57), the Leisure Time Exercise Questionnaire (r = 0.41), a 7-day physical activity recall interview (r = 0.46), a Caltrac motion sensor (r = 0.39), and a Canadian Home Fitness Test (step test) of fitness (r = 0.28) (Kowalski, Crocker, & Faulkner, 1997).

The Physical Activity Questionnaire for Adolescents (PAQ-A) was developed specifically for use in the adolescent population. The PAQ-A is identical to the PAQ-C, with exception to the omission of one question involving recess activity time. The PAQ-A was found to be a reliable and valid method in 13 to 20 year olds (n = 85) when compared to an activity rating (r = 0.73), the Leisure Time Exercise Questionnaire (r = 0.57), a 7-day physical activity recall interview (r = 0.59), and a Caltrac motion sensor (r

= 0.33) (Kowalski, Crocker, & Kowalski, 1997). As expected, adolescents were better able to self-report physical activity data in comparison to younger children.

Although most high schools do not include recess during the school day, some smaller rural schools (especially those that contain grades 1 through 12 inclusive) still have daily recess. In the present research, students were given the option of selecting that they do not have recess instead of using the PAQ-A which omits the recess activity question from the PAQ-C.

One limitation of both the PAQ-C and the PAQ-A is that sedentary activity levels are not calculated. Therefore, it may be beneficial to use additional survey tools or questions simultaneously with the PAQ-C or PAQ-A. Further, researchers cannot distinguish between moderate and vigorous activity; only a summary activity score is calculated. The PAQ-C was designed for use in schools, therefore summer or holiday time activity cannot be determined using this assessment method. However, the PAQ-C and PAQ-A are cost- and time-efficient methods that have been widely used in the Canadian population (Kowalski et al., 2004).

2.2.2.2 Pedometer Records

Although subjective methods such as the PAQ-C or the PAQ-A can be used to assess physical activity, there are other methods that do not rely on self-report. Objective methods such as activity monitors (e.g., pedometers) can be used to gain a more direct understanding of physical activity levels in youth. Pedometers are digital devices that are generally worn on the hip and can estimate the number of steps taken over a period of time. Because pedometers register only vertical movements, they are unable to assess activities such as swimming, cycling, or movements of the upper body (e.g., rowing). Other estimates of activity should be used during these activities in order to assess total physical activity. Tudor-Locke et al. (2004) has suggested that 10 minutes of activity equals approximately 1,000 steps and therefore can be used to estimate activity when the pedometer cannot be used. Pedometers are also unable to determine intensity and duration of activities and do not log activity, however they do provide a good overall assessment of total activity. Frequently, researchers use pedometer log books (steps/day) in order to assess multiple days of activity.

Pedometers have been validated for use in adults (Tudor-Locke, Williams, Reis, & Pluto, 2002, 2004) however there is less information on the use of pedometers in adolescents. It is believed that by the time adolescents reach high school, they become cognitively and behaviourally more similar to adults than children (Welk, Corbin, & Dale, 2000). Therefore, most studies conducted have not focused on older adolescents. However, there are a number of studies that assessed the validity of pedometer use in children and younger adolescents. In a study by Kilanowski et al. (1999) (children 7 – 12 years), pedometers (Yamax Digiwalker SW-200) showed a strong association with the Children's Activity Rating Scale direct observation method for both recreational ($r = 0.97$) and classroom ($r = 0.80$) activities. In order to assess energy cost of activity, a study by Eston et al. (1998) (children 8 – 11 years) examined the relationship between pedometer step counts (Yamax Digiwalker DW-200) during activities and sVO_2 (scaled oxygen uptake, VO_2 scaled to body mass$^{-0.75}$) measured every 30 seconds. When compared to sVO_2, pedometer step counts revealed correlations that ranged from $r = 0.81$ for all activities to $r = 0.92$ for unregulated play activities including hopping, catching and crayoning. A comparable study by Louie and colleagues (1999) that examined the energy cost of activity showed similar correlations between the Digiwalker DW-200 pedometer and sVO_2 (scaled oxygen uptake, VO_2 scaled to body mass$^{-0.75}$). Correlations ranged from r = 0.86 for all activities and r = 0.93 for unregulated play activities including hopping, catching, and crayoning (Louie et al., 1999).

Although pedometers have been validated as an objective measure of physical activity, some concern exists regarding reactivity in measuring devices. Reactivity can be defined as "a change in normal activity patterns when participants' know that their activity levels are being monitored" (Vincent & Pangrazi, 2002, p. 56). If reactivity does exist it is important to account for this phenomenon during data analysis. However, two studies have shown that reactivity does not exist when measuring activity levels in children with both unsealed (Ozdoba, Corbin, & Masurier, 2004) and sealed (Vincent & Pangrazi, 2002) pedometers.

In addition, recommended levels of physical activity (as measured by steps/day) in relation to BMI have been established for 6 to 12 year old boys and girls. Levels of 15,000 steps/day for boys and 12,000 steps/days for girls have been suggested as a recommended level to promote health. Children that did not meet these criteria (boys taking < 15,000 steps/day and girls taking < 12,000 steps/day) were more likely to be classified as overweight or obese (Tudor-Locke, Pangrazi et al., 2004). Overall, the pedometer is a relatively inexpensive, reusable and reliable objective measure that can be used in the assessment of physical activity in children and adolescents (Sirard & Pate, 2001).

2.2.2.3 Shuttle Run

The 20-metre shuttle run test (20mSRT) is a well-established fitness assessment that was originally developed by Léger and Lambert (1982) to simulate a graded exercise test in adults. The original shuttle run test consisted of two minute stage intervals, however it was determined that two minutes was too long and psychologically boring for children, thus a revised test consisting of one-minute stages was designed with a starting speed of 8.5 kilometers/hour, increasing by 0.5 kilometers/hour every minute (Léger, Mercier, Gadoury, & Lambert, 1988). The resulting test was found to be a reliable (children 6 – 16 years, r = 0.89; and adults 20 – 45 years, r = 0.95) and valid (children 8 – 19 years, r = 0.71; adults 18 – 50 years, r = 0.90) method of fitness assessment when compared to VO_2max (Léger et al., 1988). Separated by stages, each increase in stage has a one metabolic equivalent (MET) increase. One MET (3.5 ml O2 / kg * min) can be described as "the energy (oxygen) used by the body as you sit quietly" (Centers for Disease Control and Prevention, 2006a, para. 5). Examples of activities at one MET include reading or talking on the phone. During the 20mSRT participants run between parallel lines 20-meters apart to a predetermined audio signal. Once participants become too exhausted to continue, or are unable to maintain the pace of running, the test is completed and researchers record the stage last completed by the participant. This can then be converted to running speed at the last completed one-minute stage in order to determine levels of fitness (Tomkinson, Leger, Olds, & Cazorla, 2003).

Since the development of the revised 20mSRT, many studies have continuously shown good reliability and validity in predicting fitness. Studies have been conducted in the U.S. (Liu, Plowman, & Looney, 1992), the U.K. (Boreham, Paliczka, & Nichols, 1990; Boreham, Twisk, Savage, Cran, & Strain, 1997; Mahoney, 1992; McVeigh, Payne, & Scott, 1995), China (Barnett, Chan, & Gruce, 1993), Tasmania (Cooley & McNaughton, 1999), and Japan (Matsuzaka et al., 2004). According to Tomkinson et al. (2003), the 20mSRT is likely the most widely used test to assess the aerobic fitness of children and adolescents.

There are many advantages of the 20mSRT compared to other fitness tests including distance runs. The space required to complete the 20mSRT is not extensive and therefore can be carried out indoors, including most school gymnasiums. This removes the variability that could potentially result from seasonal variations.

2.2.3 Anthropometric Measurements

Anthropometric measures including height, weight, Body Mass Index (BMI), waist circumference (WC), and bioelectrical impedance analysis (BIA) are frequently used to monitor growth in adolescents. These indicators are used because they are non-invasive, economical, and have been shown to be valid and reliable in the determination of total body fat (Himes, 1999). Measures are generally selected based upon convenience (time and burden to the participant), cost (cost of performing the measurement and cost of the equipment), and the skill required to perform each measurement. Reliability of each anthropometric assessment depends upon correct calibration of equipment and the proficiency of the anthropometrist (Wang, Thornton, Kolesnik, & Pierson, 2000). Validity varies depending on the demographic variables of the individuals being measured including age, gender and ethnicity as well as the anthropometric measurement itself.

2.2.3.1 Body Mass Index (BMI)

Body weight tends to be correlated with adiposity (Pietrobelli et al., 1998), and height (Power, Lake, & Cole, 1997); therefore, weight-for-height indices such as body mass index (BMI; weight (kg)/height (m^2)), the Ponderal index (height (m)/weight (kg$^{1/3}$)), and the Rohrer index (weight (kg)/height (m^3)) are used to assess growth, with the most common and desirable being BMI (also referred to as Quetelet index) (Cole, 1991; Flegal, Tabak, & Ogden, 2006). Further, BMI varies substantially with age in children and adolescents, where BMI tends to increase in the first few years of life, decreases during early childhood (until age six), and then increases again during adolescence up until adulthood (Rolland-Cachera et al., 1987; Siervogel, Roche, Guo, Mukherjee, & Chumlea, 1991). Due to the substantial difference of BMI between life stages, BMI is of greater value when compared to reference populations of the same age and sex. In two validation studies, BMI was compared to triceps skinfold thickness (Malina & Katzmarzyk, 1999) and dual energy x-ray absorptiometry (DXA) (Pietrobelli et al., 1998). Both concluded BMI was a reliable and valid method to assess overweight and obesity in children and adolescents. Specifically, Pietrobelli et al. (1998) demonstrated that BMI was strongly correlated with total body fat ($R^2 = 0.89$ and 0.85 for boys and girls respectively), as well as percent of body weight as fat ($R^2 = 0.69$ and 0.63 for boys and girls respectively) when compared to DXA.

In the United States, the Centers for Disease Control and Prevention (CDC) developed BMI reference data, the 2000 CDC growth charts, using five nationally representative survey data sets including the National Health Examination Survey

(NHES) cycles II and III (1963 – 1965 and 1966 – 1970), and the first, second and third National Health and Nutrition Examination Surveys (NHANES): NHANES I (1971 – 1974), NHANES II (1976 – 1980), and NHANES III (1998 – 1994) (Kuczmarski et al., 2000). The 2000 CDC growth charts were revised using the 1977 National Center for Health Statistics growth charts, and include BMI-for-age curves that can be used to identify "risk of overweight" and "overweight" for children and adolescents (Kuczmarski et al., 2002). Risk of overweight was defined as a BMI-for-age at or above the 85th percentile, and less than the 95th percentile; while overweight was defined as a BMI-for-age above the 95th percentile (Ogden, 2004). The World Health Organization has adapted the 2000 CDC growth charts for worldwide use (Kuczmarski et al., 2000).

In 2000, Cole and colleagues developed an internationally acceptable definition of childhood overweight and obesity using six nationally representative data sets from Brazil, Great Britain, Hong Kong, the Netherlands, Singapore and the United States (n = approximately 200,000). Derived from adult BMI cut-off points (25 and 30 kg/m^2 for overweight and obesity respectively), age and sex specific cut-off points for youth 2 to 18 years were extrapolated by placing these values (25 kg/m^2 and 30 kg/m^2) at 18 years of age where prevalence of overweight and obesity were matched (see **Table 2.1**). Referred to as the International Obesity Task Force (IOTF) cut-offs, these values were intended to provide a means to compare prevalence estimates internationally (Cole, Bellizzi, Flegal, & Dietz, 2000). In comparison to the 2000 CDC growth charts, the IOTF cut-offs give lower estimates of overweight in young children, and higher estimates of overweight for older children as seen in a sample of U.S. children and adolescents. With the exception of the oldest children, the IOTF cut-offs give lower estimates of obesity compared to the 2000 CDC growth charts (Flegal, Ogden, Wei, Kuczmarski, & Johnson, 2001).

Each of the two methods, the 2000 CDC growth charts and the IOTF cut-offs, give different estimates of prevalence, therefore it is important to utilize the method best suited to the demographics and design of individual research studies. The CDC growth charts were developed solely using U.S. data, therefore it is best suited to studies occurring in the United States. Alternatively, the IOTF cut-offs were developed using data from six different countries, making it more appropriate for international comparisons. Further, the IOTF cut-offs give estimates of overweight and obesity based on adult weight classifications.

Recently, Dietitians of Canada, the Canadian Paediatric Society, the College of Family Physicians of Canada, and the Community Health Nurses Association of Canada recommended the use of the 2000 CDC growth charts in clinical and community settings, and the IOTF cut-offs in group comparisons of overweight and obesity in youth. Since Canadian data were not included in either reference, it should be noted that these recommendations were based on expert opinion (Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, & Community Health Nurses Association of Canada, 2004). Therefore, until Canadian data are available, reference data must be used that may not take into consideration the unique characteristics of Canadian youth (Ball & Willows, 2005).

Table 2.1: Age and Sex-Adjusted BMI Cut-Points for Overweight and Obesity for Youth 9-17 Years

Age (years)	Overweight (BMI)		Obese (BMI)	
	Boys	Girls	Boys	Girls
9	≥ 19.10 & < 22.77	≥ 19.07 & < 22.81	≥ 22.77	≥ 22.81
10	≥ 19.84 & < 24.00	≥ 19.86 & < 24.11	≥ 24.00	≥ 24.11
11	≥ 20.55 & < 25.10	≥ 20.74 & < 25.42	≥ 25.10	≥ 25.42
12	≥ 21.22 & < 26.02	≥ 21.68 & < 26.67	≥ 26.02	≥ 26.67
13	≥ 21.91 & < 26.84	≥ 22.58 & < 27.76	≥ 26.84	≥ 27.76
14	≥ 22.62 & < 27.63	≥ 23.34 & < 28.57	≥ 27.63	≥ 28.57
15	≥ 23.29 & < 28.30	≥ 23.94 & < 29.11	≥ 28.30	≥ 29.11
16	≥ 23.90 & < 28.88	≥ 24.37 & < 29.43	≥ 28.88	≥ 29.43
17	≥ 24.46 & < 29.41	≥ 24.70 & < 29.69	≥ 29.41	≥ 29.69

Adapted from Cole et al. (2000)

2.2.3.2 Self-Reported Height and Weight

Self-reported height and weight are often used to determine BMI, which is then used to determine overweight and obesity status in epidemiological and other research studies. Self-report offers researchers a time- and cost-effective method to survey a large number of participants simultaneously; however, there is concern in the literature over the reliability and validity of these measurements. Numerous studies have examined self-reported height and weight in adults (Flood, Webb, Lazarus, & Pang, 2000; Himes & Roche, 1982; Jacobson & DeBock, 2001; Palta, Prineas, Berman, & Hannan, 1982; Rowland, 1990), with the general conclusion being that adults overestimate height and underestimate weight. However, there is less information on the reliability and validity of self-report in children and adolescents.

Strauss (1999) examined measured and self-reported heights and weights in a sample of 1,657 adolescents ages 12 to 16 years that were enrolled in the NHANES III study. Correlations between self reported weight and actual weight ranged between 0.87 and 0.94, thus self-report was deemed a reliable and appropriate method to assess obesity related behaviours in cross-sectional studies. Females and obese adolescents were more likely than males and non-obese adolescents to under-report their weight, however there were no differences in the accuracy of self-reported height between gender or ethnic groups. It should be noted that while the author recommended the use of self-report for cross-sectional studies, it was not recommended to use self report when tracking weight changes in longitudinal studies where more precise measurements are necessary. Utilizing a similar sample of adolescents (n = 1,635) from the NHANES III study, Himes and Faricy (2001) investigated the validity and reliability of self-reported height and weight in adolescents ages 12 to 16 years and found that the intraclass coefficients between measured and self-reported data in 14 to 16 year olds ranged from 0.81 to 0.91 and 0.92 to 0.98 for height and weight respectively. Due to large amounts of missing data, the use of self-report from adolescents less than 14 years was not recommended.

A more recent study (Brener, McManus, Galuska, Lowry, & Wechsler, 2003) of grade 9 through 12 students (n = 4,619) living throughout the United States was completed to examine the reliability and validity of self-reported height and weight compared to measured height and weight. The authors determined that self-reported height and weight at time 1 and time 2 (approximately two weeks apart) were highly correlated (r = 0.93 for both height and weight). Further, the correlations between self-reported and measured heights and weights were 0.90 and 0.93 respectively. Mean differences for height were 2.7 inches (greater self-reported height), and mean differences for weight were 3.5 pounds (greater measured weight), resulting in a 2.6 kg/m^2 lower BMI value compared to BMI calculated using measured height and weight. It was also found that female students were more likely than males to underreport their weight (Brener, McManus et al., 2003).

The Waterloo web-based survey found similar results, showing that height and weight self-reported by grade 6 through 8 students (n = 51) was highly correlated with measured height (r = 0.84) and weight (r = 0.94). Interclass correlation estimates also showed good agreement for height (80%) and weight (87%) (Hanning, Jessup, Lambraki, MacDonald, & McCargar, 2003).

Although measured height and weight are more precise and accurate than self-reported measurements, self-report is a useful method that can be used in cross-sectional studies in order to determine obesity-related behaviours. When assessing weight changes over time, it is important to use measured values, as more sensitivity is required.

2.2.3.3 Waist Circumference

Waist circumference (WC) is an indirect measurement of abdominal fat, and is accepted as a good predictor of obesity-related health problems such as dyslipidemia and hyperinsulinemia in adolescents (Freedman, Serdula, Srinivasan, & Berenson, 1999). In a sample of 2,996 children and adolescents that participated in the Bogalusa Heart Study, children at the 90th percentile for waist circumference had, on average, higher concentrations of insulin (6 pmol/L), triacyglycerol (0.11 mmol/L), low-density lipoprotein (LDL) cholesterol (0.17 mmol/L) and lower concentrations of high-density lipoprotein (HDL) cholesterol (-0.07 mmol/L) compared to those at the 10th percentile (p = 0.001). Although not significant, these differences appeared to increase with age (Freedman et al., 1999). Additional studies, including a study by Janssen and colleagues (2005) have shown evidence to support the use of WC in combination with BMI to determine coronary artery disease (CAD) risk factors. As previously mentioned, BMI is the method currently recommended for the identification of overweight and obesity in adolescent Canadians (Dietitians of Canada et al., 2004). Although BMI is an independent predictor of CAD risk factors in adults (National Institutes of Health, 1998), BMI in combination with WC has been shown to be a better predictor of health risks in the adolescent population than BMI or WC alone (Janssen et al., 2005).

Although it has been established that WC is an important indicator of health risks in youth, there is no universally accepted standard method of measuring WC (Wang et al., 2000). Methods defined in terms of anatomic landmarks include measuring immediately below the lowest ribs, at the narrowest waist, the midpoint between the lowest rib and iliac crest, and immediately above the iliac crest (Wang et al., 2003). For any method, WC should be measured by an experienced anthropometrist using a flexible heavy-duty inelastic tape measure (Wang et al., 2000). During the measurement, the tape measure is placed around the subject, directly over the skin (if possible) while the subject stands balanced on both feet, with the arms at their sides and the feet together (Wang et al., 2003). Waist circumference is measured at the end of a normal expiration.

Recently, WC reference data for Canadian youth were developed using nationally representative data from 3,064 adolescents 11 to 18 years of age that participated in the 1981 Canada Fitness Survey (CFS). Smoothed and weighted age- and sex-specific percentile curves were developed for Canadian youth 11 to 18 years of age. Boys had a greater mean WC than girls at every age, and WC increased with age for both boys and girls (Katzmarzyk, 2004).

2.2.3.4 Bioelectrical Impedance Analysis

Bioelectrical impedance analysis (BIA) is a method that is frequently used in body composition testing because it is noninvasive, relatively simple and inexpensive to perform. The portability of BIA creates an attractive alternative to other methods, especially when carrying out epidemiologic and field studies. BIA relies on the principle that electrical resistance is lower in individuals with increased fat-free mass (FFM) compared to those with increased fat mass. This is because individuals with greater FFM also have greater amounts of total body water (TBW), which allows the BIA current to travel through the body more quickly, and hence less resistance (Kyle et al., 2004). Once performed, BIA allows the determination of TBW and FFM using resistance and reactance obtained from the measurement.

Although BIA has been validated against several methods including DXA (Okasora et al., 1999), there is still confusion in the literature regarding the appropriateness of prediction equations for various populations, including the adolescent population. While numerous prediction equations have been developed to determine FFM from BIA, very few equations have been developed and validated specifically for adolescents. Because the relationship between bioelectrical resistance and total body water is influenced by age (Deurenberg, Kusters, & Smit, 1990), it is essential to have age-specific equations when utilizing BIA for the measurement of body composition.

One exception is the equation by Houtkooper et al. (1992), which was developed and cross-validated using several samples of subjects from three different locations. Body composition was measured in children and adolescents 10 to 19 years of age using body density as measured by hydrostatic weighing, and body water estimated from deuterium dilution. Subjects also completed BIA and anthropometric (weight, triceps skinfold, circumferences, standing height, and skeletal widths) measurements. Ten sets of independent variables were used in regression models in order to determine the best prediction equation. The resulting regression equation for fat free body mass showed a variation of 0.91 to 0.95, a standard error of the estimate of 2.1 kg to 2.9 kg, and coefficients of variation at 5.1% to 7.0% (Houtkooper et al., 1992).

Although BIA is a convenient and attractive method that can be used to assess body composition, the measurement relies on the assumption of a normal hydration and electrolyte status (Kyle et al., 2004). In addition, only few validation studies have been done in the adolescent population. However, the portability, noninvasiveness, and low cost of performing BIA make this method appropriate for use in the research presented in this thesis.

2.2.4 Web-Based Surveys

Web-based methods of surveillance provide unique opportunities to survey large numbers of participants concurrently throughout wide geographic areas. Access to hard-to-reach areas is enhanced, thus improving the ability to obtain a representative sample (Eaton & Struthers, 2002). Web-based surveys can also be tailored to specific populations or research by using enhanced pictures or interactive components that accompany the questionnaire or assessment methodology (Robinson et al., 2002). The University of Waterloo Food Behaviour Questionnaire utilizes portion size images and interactive reminders (beverages, toppings) throughout an on-line 24-hour dietary recall. Other researchers have shown that when using a computer to collect data on health behaviours, 94% of adolescents 12 to 18 years of age (n = 98) found that answering a questionnaire using a computer was "easy", and 72% stated the computer was either "somewhat cool" or "very cool". No students found using the computer difficult (Robinson et al., 2002). Adolescents are likely to be familiar with computer and internet technology, especially in Alberta where the SuperNet was implemented in 2002, which provides high-speed internet service to thousands of facilities (government offices, schools, health care facilities, libraries) in 429 communities throughout the province of Alberta (Government of Alberta, 2002). Furthermore, the Household Internet Use Survey (2003) indicated that Alberta and Ontario had two of the highest rates of internet use, where 58% and 60% of households were connected to the internet respectively.

Some errors and bias are reduced when using web-based methodologies. Web-based surveys eliminate interviewer bias by standardizing the interaction a participant has with the survey. Data entry errors are also non-existent. Web-based methodologies utilize databases electronically linked to surveys, which eliminates the need for manual data entry (Rhodes, Bowie, & Hergenrather, 2003). Web-surveys have also been shown to increase the reporting of sensitive behaviours in adolescents such as health-protective behaviours, substance abuse and sexual behaviours (Webb, Zimet, Fortenberry, & Blythe, 1999). Web-surveys provide anonymity and privacy which other methods (such as face-to-face interviewing) do not allow. Although nutrition and physical activity behaviours are generally not thought of as sensitive behaviours, many adolescents have perceptions of socially desirable answers in regards to these behaviours (Brener, Billy et al., 2003). It has been shown that anonymity and privacy are important determinants when adolescents choose to report honest answers (Ginsburg et al., 1995; Supple, Aquilino, & Wright, 1999). In a study done by Robinson et al. (2002) students were able to give comments after completing a computer-based questionnaire. Student comments included: "I think this survey was pretty cool. I answered the questions truthfully. I wasn't scared to because I know they won't know it was me."; and "Some of the questions were very personal things that I wouldn't tell anyone. I didn't really mind because no one will be able to know it was me. It was pretty fun." (Robinson et al., 2002, p. 5). Reactivity can also be decreased when using web-based surveys, as researchers can establish a testing schedule in such a way that participants do not know the exact day on which the survey is going to take place. Furthermore, anonymity and privacy are extremely important when conducting research in schools, as many school administrators require surveys to be anonymous, making web-based surveys an attractive method for all individuals involved.

Although web-based surveys have many advantages, there are also limitations when using web-based methodology. Researchers are often not able to control the setting when data collection takes place, therefore the environment, motivation and time of day may effect data collection. Web-based surveys utilize self-report, which is independently associated with limitations such as accuracy and literacy. Further, many individuals may not have access to a computer, which limits the use of web-based methodology.

Although web-based surveys have several limitations, the advantages have led many organizations to move towards the use of computer- and web-based tools and surveys such as www.dietitians.ca and the Dole 5 a Day Virtual Classroom (DiSogra & Glanz, 2000). Another computer-based dietary assessment tool, the Food Intake Record Software System (FIRSSt), was found to be a promising method when compared with direct observation during a lunch period and a dietitian administered 24-hour recall with 138 fourth grade students (Baranowski et al., 2002). FIRSSt was compared to matches (food in both the FIRSSt and either direct observation or dietitian administered 24-hour recall), intrusions (food in FIRSSt but not in direct observation or dietitian administered 24-hour recall), and omissions (food not in FIRSSt but in direct observations or dietitian administered 24-hour recall). Results indicated that when compared to direct observation FIRSSt obtained 46% matches, 24% intrusions, and 30% omissions. In comparison to dietitian administered 24-hour recall, FIRSSt obtained 60% matches, 15% intrusions, and 24% omissions (Baranowski et al., 2002). When compared to written self-administered questionnaires, a Computer Assisted Self-Interview (CASI) showed no significant differences between self-reported and computer assisted assessment methods for physical activity and eating habits (Webb et al., 1999). Although there are challenges when using self-reported data, the adaptability and flexibility of web-based tools makes the internet an efficient, cost effective and practical solution when collecting and managing data.

2.3 Lifestyle Behaviours

Lifestyle behaviours such as nutrition and physical activity are important determinants of obesity. Adolescents are at a life stage where they have increasing independence and autonomy regarding nutrition and physical activity which often persist into adulthood. Guidelines and recommendations have been established by numerous government agencies and organizations, however many individuals are still not meeting these goals. This section will review Canadian nutrition and physical activity recommendations in addition to current dietary intakes and levels of physical activity in the adolescent population.

2.3.1 Nutrition

2.3.1.1 Current Recommendations

Food Guides

Canada's first food guide, the Official Food Rules released in 1942, was the first of many food guides developed to help improve the health of Canadians. Since 1942, there have been many versions of the food guide including Canada's Food Rules (1944, 1949), Canada's Food Guide (1961, 1977, 1982), and Canada's Food Guide to Healthy Eating (CFGHE; 1992) (Health Canada, 2002). Food guides are developed using nutrient requirements, consumption surveys, food supply and production issues, and national nutrition goals; however they are translated into a language that is easy for the general population to understand (Health Canada, 2002). Canada's Food Guide was revised in the 1990s in order to provide a practical reference to guide consumers when making food choices and to inform individuals on the benefits of a healthy diet by using healthy eating messages. This resulting food guide, CFGHE released in 1992, is now one of the most recognized government documents in Canada, and the most popular site on the Health Canada website (Health Canada, 2002). In a Health Canada survey (n = 3,005) more than eight in ten (86%) and nearly seven in ten (68%) adults reported being aware of or having looked at CFGHE, respectively (Health Canada, 2003a). CFGHE is characterized by the rainbow graphic and was the first food guide to incorporate a total diet approach of food selection which emphasizes both energy and nutrient needs of individuals (Health Canada, 2002). The food guide recognizes that nutritional needs vary between individuals; therefore recommendations are provided as ranges for individuals four years of age and older. Furthermore, CFGHE incorporates a "Vitality", or total well-being message which promotes healthy eating, active living, and feeling good about oneself. Canada's Food Guide to Healthy Eating was recently revised and the new food guide, Eating Well with Canada's Food Guide (Health Canada, 2007), was released on February 5, 2007. In comparison to the 1992 food guide, the 2007 food guide includes specific recommendations for individuals within different life stage and gender groups. In spite of this, the 1992 CFGHE was the government recommendation during data collection for all research presented in this thesis and was also a component of the Alberta (Alberta Learning, 2002, 2005) and Ontario (Ontario Ministry of Education, 2000, 2005) school curricula. Therefore, it is most appropriate to compare intakes to the 1992 CFGHE recommendations.

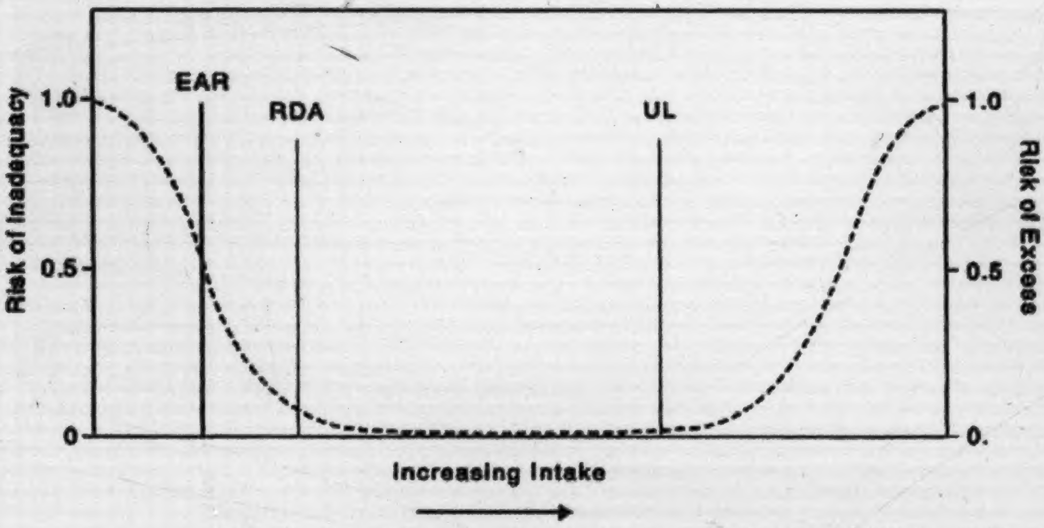
Canada's Food Guide to Healthy Eating is divided into four food groups including Grain Products, Vegetables and Fruit, Milk Products and Meat and Alternatives. An Other Foods category includes foods containing mostly fats and oils (butter, margarine, cooking oils, lard), mostly sugar (jam, honey, syrup, candies), high fat and/or high salt snack foods (chips [potato, corn], pretzels), beverages (water, tea, coffee, soft drinks), high fat and/or high sugar (pastries), and herbs, spices and condiments (mustard, ketchup) (Health Canada, 2006).

Food group recommendations were established as ranges in order to accommodate both males and females at different ages, body sizes, and activity levels. Individuals with higher nutritional requirements such as male adolescents are advised to choose higher amounts from the food group ranges. Recommendations are as follows: Grain Products, 5 – 12 servings per day; Vegetables and Fruit, 5 – 10 servings per day; and Meat and Alternatives, 2 – 3 servings per day. Milk Products are divided into life stage groups including children 4 to 9 years (2 – 3 servings per day), youth 10 to 16 years (3 – 4 servings per day), adults (2 – 4 servings per day), and pregnant and breast-feeding women (3 – 4 servings per day). It is recommended to consume Other Foods in moderation (Health Canada, 1992).

Dietary Reference Intakes

Dietary Reference Intakes (DRIs) are a set of four quantitative estimates of nutrient intakes that can be used when assessing and planning the diets of healthy individuals. The DRIs are composed of an Estimated Average Requirement (EAR), Recommended Dietary Allowance (RDA), Adequate Intake (AI), and Tolerable Upper Intake Level (UL). Developed to replace the former RDAs in the United States and the Recommended Nutrient Intakes (RNIs) in Canada, the DRIs were established using data from both countries, therefore providing the best evidence available to promote the health and well-being of all North Americans. Differences exist between the former RDAs and RNIs and the current DRIs, including a shift in focus to the reduction of chronic disease which replaced previous recommendations that were established based on the absence of deficiency. Nutrients have a set of DRIs depending upon the level of sufficient evidence available. Nutrients may either have an EAR (and hence an RDA), or an AI recommendation. Additionally, ULs were developed for many nutrients as part of the new DRIs (Institute of Medicine, 2000d). **Figure 2.1** provides a visual representation of the DRIs in relation to risk of inadequacy and risk of excess.

Figure 2.1: Dietary Reference Intakes



From Institute of Medicine (2000c)

The EAR "is the median usual intake value that is estimated to meet the requirement of half the healthy individuals in a life stage and gender group" (Institute of Medicine, 2000d, p. 23). When nutrition intakes and nutrient requirements are not correlated, the EAR can be used to determine levels of nutrient inadequacy in groups by utilizing the EAR cut-point method. This method provides a percentage of the sample below the EAR, or the proportion of individuals with inadequate intakes. Estimated Average Requirements are also used to calculate RDAs using the equation RDA = EAR + 2 $SD_{requirements}$. The primary purpose of the RDA is to provide a goal intake for individuals, and is defined as "the average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all healthy individuals in a particular life stage and gender group" (Institute of Medicine, 2000d, p. 24). When an EAR cannot be established (and thus a RDA cannot be determined), an AI is developed. The AI is "the recommended average daily nutrient intake level based on experimentally derived intake levels or approximations of observed mean nutrient intakes by a group (or groups) of apparently healthy people who are maintaining a defined nutritional state or criterion of adequacy" (Institute of Medicine, 2000d, p. 25). AIs are used when assessing the diets of groups and individuals; however they cannot be used to determine inadequacy.

When there is sufficient evidence, a UL can also be established. The UL "is the highest level of continuing daily nutrient intake that is likely to pose no risk of adverse health effects in almost all individuals in the specified life stage group" (Institute of Medicine, 2000d, p. 25). The UL is not a recommendation, thus it is generally used when evaluating the diets of individuals. **Table 2.2** provides selected nutrient DRIs, by life stage and gender group, for adolescent boys and girls.

Table 2.2: Dietary Reference Intakes: Recommended Intakes for Individuals

Nutrient	Life Stage and Gender Group	Dietary Reference Intakes (DRIs)	
		RDA (EAR)	AI
Vitamin A (μg/day)	Boys 9-13 y	600 (445)	
	Boys 14-18 y	900 (630)	
	Girls 9-13 y	600 (420)	
	Girls 14-18 y	700 (485)	
Vitamin C (mg/day)	Boys 9-13 y	45 (39)	
	Boys 14-18 y	75 (63)	
	Girls 9-13 y	45 (39)	
	Girls 14-18 y	65 (56)	
Iron (mg/day)	Boys 9-13 y	8 (5.9)	
	Boys 14-18 y	11 (7.7)	
	Girls 9-13 y	8 (5.7)	
	Girls 14-18 y	15 (7.9)	
Niacin (mg/day)	Boys 9-13 y	12 (9)	
	Boys 14-18 y	16 (12)	
	Girls 9-13 y	12 (9)	
	Girls 14-18 y	14 (11)	
Zinc (mg/day)	Boys 9-13 y	8 (7)	
	Boys 14-18 y	11 (8.5)	
	Girls 9-13 y	8 (7)	
	Girls 14-18 y	9 (7.3)	
Vitamin D (μg/day)	Boys 9-13 y		5
	Boys 14-18 y		5
	Girls 9-13 y		5
	Girls 14-18 y		5
Calcium (mg/day)	Boys 9-13 y		1,300
	Boys 14-18 y		1,300
	Girls 9-13 y		1,300
	Girls 14-18 y		1,300
Fibre (g/day)	Boys 9-13 y		31
	Boys 14-18 y		38
	Girls 9-13 y		26
	Girls 14-18 y		26

(Institute of Medicine, 1997, 1998, 2000a, 2000b, 2005)

Acceptable Macronutrient Distribution Ranges (AMDRs) were established in order to promote a balanced diet composition which contains adequate intakes of essential nutrients and aids in the prevention of chronic disease. Acceptable Macronutrient Distribution Ranges for children and adolescents ages 4 to 18 years were established for carbohydrate (45 – 65% of energy), protein (10 – 30% of energy), and fat (25 – 35% of energy). In comparison, AMDRs for adults are the same for carbohydrate (45 – 65% of energy), and similar for protein (10 – 35% of energy), and fat (20 – 35% of energy) (Institute of Medicine, 2005).

Canada's Food Guide to Healthy Eating and the DRIs are invaluable tools that can be used to assess and plan the diets of individuals. Further, prevalence of nutrient inadequacy can be determined when assessing diets using the DRIs. Together, these resources provide important information when describing the current dietary intakes of groups within the Canadian population.

2.3.1.2 Current Dietary Intakes of Adolescents

Recent findings from the 2004 CCHS suggest that many children and adolescents are not meeting recommendations based on CFGHE. The largest and most comprehensive survey conducted in Canada, the 2004 CCHS, includes data from over 35,000 face-to-face 24-hour dietary recalls, with nearly 11,000 individuals having completed a second dietary recall (Garriguet, 2004). The 2004 survey included Canadians of all ages, however for the purpose of the literature review, only Canadian youth (4 – 19 years) will be discussed.

Utilizing data from two 24-hour dietary recalls, results from the 2004 CCHS indicated that the largest caloric contributor (categorized by food groups) to the diet of children and adolescents ages 4 to 18 years was from Grain Products (31%), however the second largest contributor was from Other Foods (22%). This is concerning, as the recommendation for Other Foods is to consume these foods in moderation. Usual servings from each of the four food groups were also estimated as a component of the 2004 CCHS. The Meat and Alternatives food group was assessed using a recommendation of 100 to 300 grams of cooked meat, the equivalent of 2 – 3 servings based on CFGHE. Children and adolescents met the minimum recommendations for Meat and Alternatives (9 to 13 years: boys = 176 grams, girls = 130 grams; 14 to 18 years: boys = 229 grams, girls = 136 grams) and Grain products (9 to 13 years: boys = 7.09 servings, girls = 5.02 servings; 14 to 18 years: boys = 7.98 servings, girls = 5.74 servings) based on average daily servings. However, mean values of Vegetables and Fruit (9 to 13 years: boys = 4.53 servings, girls = 4.40 servings; 14 to 18 years: boys = 4.87 servings, girls = 4.45 servings) and Milk Products (9 to 13 years: boys = 2.55 servings, girls = 2.08 servings; 14 to 18 years: boys = 2.64 servings, girls = 1.82 servings) were below recommended levels (Garriguet, 2004).

Consistent with these findings, the majority of children and adolescents consumed fewer than five servings of Vegetables and Fruit with 62% of boys and 68% of girls ages 9 to 13 years below the minimum recommendation and 53% of boys and 63% of girls ages 14 to 18 years below the recommendation. Even more apparent was the proportion not meeting minimum recommendations for Milk Products with 61% of boys and 83% of girls 10 to 16 years not meeting recommendations based on CFGHE. The proportion meeting minimum recommendations of Grain Products were somewhat higher with only 6% of boys and 33% of girls (14 to 18 years) below minimum recommendations. Regardless of age, girls were more likely than boys to consume less than the minimum CFGHE recommendations. Although CFGHE recommends consuming Other Foods in moderation, over 22% (9 to 13 years), and over 25% (14 to 18 years) of calories from the diet came from food found in the Other Foods category. The top contributor in the Other Foods category for all age groups was from soft drink consumption (11% of Other Foods kilocalories) (Garriguet, 2004).

In comparison to the AMDRs, both boys and girls 9 to 13 years and 14 to 18 years were within the recommended values. Boys 9 to 13 years consumed 54.5%, 14.6% and 30.9% carbohydrate, protein and fat respectively, while girls consumed 55.5% carbohydrate, 14.0% protein, and 30.5% fat. Among older adolescents, distributions for carbohydrate, protein and fat for boys was 52.7%, 15.2% and 31.5% respectively. Girls within this age group consumed 54.3% carbohydrate, 14.4% protein, and 30.8% fat. However, many children (11% boys, 11% girls) and adolescents (16% boys, 13% girls) were above the upper end of the recommended AMDR for fat. Results indicated that adolescents (12 to 19 years) had the highest energy requirements, consuming on average 2,800 kilocalories a day for boys, and 2,000 kilocalories a day for girls (Garriguet, 2004). Results from the Food Habits of Canadians survey indicated that intakes of fibre were well below recommendations, with average intakes of fibre at 17.9 grams for boys and 14.5 grams for girls ages 13 to 17 years (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000).

The Food Habits of Canadians survey was based on a much smaller sample size, however the survey reported similar results in comparison to the 2004 CCHS. In this study 1,543 adults and 178 adolescents (13 to 17 years) within selected households were enrolled and assessed using dietitian-administered 24-hour dietary recalls. Results indicated that many adolescents did not meet the minimum recommendations for Grain Products (28.6% boys, 44.1% girls), Vegetables and Fruit (57.2% boys, 44.1% girls), Milk Products (53.6% boys, 59.2% girls), and Meat and Alternatives (38.1% boys, 57.0% girls). The Other Foods category provided more than 25% of energy, making Other Foods the most predominant source of kilocalories (Jacobs Starkey et al., 2001). On the day of the survey, 61% of adolescents reported consuming a soft drink, with the majority choosing regular soft drinks (Phillips, Jacobs Starkey, & Gray-Donald, 2004). The Food Habits of Canadians survey also assessed micronutrient status in adolescents. Although intakes were not adjusted to account for intra-individual variation as recommended by the Institute of Medicine (Institute of Medicine, 2000d), mean intakes were assessed. Mean intakes of vitamin A (boys = 1888 RE; girls = 1434 RE), vitamin C (boys = 173 mg; girls = 214 mg), calcium (boys = 1407 mg; girls = 1004 mg), iron (boys = 22.2 mg; girls = 15.1 mg), and zinc (boys = 15.8 mg; girls = 9.8 mg) were all above recommendations when compared to the RNI. Although current recommendations (DRIs) are different for each micronutrient, all mean micronutrient intakes presented in the Food Habits of Canadians survey are above either the RDA or AI (DRIs) with the exception of calcium intakes in girls which was below the recommended AI (Gray-Donald et al., 2000). The 2003 Children's Lifestyle And School performance Study (CLASS) found similar results in grade five Nova Scotia students (n = 5,200), with average micronutrient intakes of vitamin A (boys = 1015.8 RAE; girls = 984.2 RAE), vitamin C (165.4 mg), iron (boys = 13.5 mg; girls = 12.3 mg), zinc (9.7 mg), calcium (1157 mg), and vitamin D (242.0 IU) (Veugelers, Fitzgerald, & Johnston, 2005).

The 2004 CCHS also examined meal behaviours. When surveyed, approximately 10% of individuals reported skipping breakfast the day before they were interviewed. Among children and adolescents, approximately 17% of kilocalories came from breakfast, in comparison to 24% at lunch, 31% at dinner and 27% at other times. Between-meal food consumption peaked between the ages of 14 to 18 with snack foods contributing 30% (boys) and 28% (girls) of kilocalories to the diet. Although snack foods can come from a variety of sources, the CCHS found that 41.5% of kilocalories from between-meals consumption came from the Other Foods category. Furthermore, approximately one-third of adolescents reported consuming food prepared at a fast food outlet compared to 23% of boys and 19% of girls 9 to 13 years (Garriguet, 2004).

2.3.2 Physical Activity

2.3.2.1 Current Recommendations

Physical Activity Guides

Developed by the Public Health Agency of Canada and the Canadian Society for Exercise Physiology, Canada's Physical Activity Guide to Healthy Active Living (CPAG) encourages individuals to make wise choices about physical activity (Health Canada, 2003b). Like CFGHE, CPAG uses a rainbow to represent physical activities that can be incorporated into everyday life. Unlike CFGHE, different Physical Activity Guides have been developed for individual life stage groups. Canada's Physical Activity Guide for Children was developed for youth ages 6 to 9 years (Health Canada and the Canadian Society for Exercise Physiology, 2002a), Canada's Physical Activity Guide for Youth was developed for individuals 10 to 14 years (Health Canada and the Canadian Society for Exercise Physiology, 2002b), and Canada's Physical Activity Guide to Healthy Active Living for Older Adults (Health Canada and the Canadian Society for

Exercise Physiology, 1999) was developed to demonstrate age is not a barrier to physical activity.

According to CPAG there are three different types of activities that are recommended to maintain health. These activities include endurance activities such as walking, skating, or cycling; flexibility activities such as yoga, curling, and gardening; and strength activities such as climbing stairs, weight/strength-training, and lifting and carrying groceries. Recommendations for each activity type include endurance (4 – 7 days a week), flexibility (4 – 7 days a week), and strength (2 – 4 days a week). It is also recommended to reduce sitting (sedentary activity) for long periods of time (Health Canada and the Canadian Society for Exercise Physiology, 1998a). The Handbook for Canada's Physical Activity Guide to Healthy Active Living recommends a goal of 60 minutes of activity every day in periods of at least 10 minutes each. Activities can be combined using light effort (60 minutes; light walking, stretching), moderate effort (30 – 60 minutes; brisk walking, biking, swimming), or vigorous effort (20 – 30 minutes; aerobics, jogging, hockey) (Health Canada, 2004; Health Canada and the Canadian Society for Exercise Physiology, 1998b).

Prior to the development of Canada's Physical Activity Guide for Youth and Canada's Physical Activity Guide for Children, youth were assessed using the CPAG for adults. Given the significant differences between activity patterns of youth and adults, these two guides provide more practical recommendations for use in younger populations. Canada's Physical Activity Guide for Youth recommends increasing physical activity by at least 30 minutes more per day up to a goal of 90 total minutes per day. Achieving this goal can be done over a five month period starting with an increase of 30 minutes per day (month one) and increasing physical activity time by 15 minutes per day during each subsequent month. It is also recommended to follow this five-month program in order to decrease sedentary (non-active) activity by up to 90 minutes per day. A combination of moderate physical activity (brisk walking, skating, and bike riding) and vigorous physical activity (running, supervised weight training, basketball, soccer) is recommended to achieve the goal of 90 minutes of activity per day (60 minutes of moderate activity and 30 minutes of vigorous activity) (Health Canada and the Canadian Society for Exercise Physiology, 2002b).

All Activity Guides (CPAG, Canada's Physical Activity Guide for Children, Canada's Physical Activity Guide for Youth, and Canada's Physical Activity Guide to Healthy Active Living for Older Adults) recommend combining a variety of activities to promote health, including endurance, flexibility, and strength activities. However, the focus of each guide is tailored to meet the specific needs of the life stage group represented. Canada's Physical Activity Guides are practical and effective tools that can be used to increase awareness surrounding the importance of physical activity in daily life.

Pedometers

Pedometers are often used to assess physical activity in adults, with an activity goal placed at 10,000 steps per day. However, Tudor-Locke et al. (2004) recognized a level of 10,000 steps per day is most likely too low to provide health benefits in children. Using data from 1,954 boys and girls ages 6 to 12 years, 15,000 steps per day for boys and 12,000 steps per day for girls were suggested as recommended levels to promote health. In this study, children that did not meet these criteria (boys taking < 15,000 steps/day and girls taking < 12,000 steps/day) were more likely to be classified as overweight or obese (Tudor-Locke, Pangrazi et al., 2004). Based on data from the U.S., Australia and Sweden, these recommendations provide higher estimates of recommended physical activity (12,000 – 15,000 steps/day = approximately 120 to 150 minutes per day of activity) compared to Canada's Physical Activity Guides. According to Tudor-Locke et al. (2004), 1,000 steps equals approximately 10 minutes of activity. Additionally, cut points have not been established for the adolescent population. More research is needed in this area to determine the longitudinal health benefits of activity at 15,000 and 12,000 steps per day for children, and whether these levels are appropriate recommendations in adolescents.

2.3.2.2 Current Activity Levels of Adolescents

Recent findings from the 2004 CCHS indicated that physical inactivity is common among overweight or obese Canadian youth. Among children 6 to 11 years, physical activity was measured using total physical activity time over a period of seven days. Only 42% of children reported being physically active more than 14 hours per week, 43% reported being active 7 to less than 14 hours per week, and 16% reported being active less than 7 hours per week (Shields, 2005). Among adolescents 12 to 17 years, physical activity was assessed based on total energy expenditure (EE) during leisure time and defined using a classification of either active (EE of 3.0 or more kilocalories per kilogram of body weight (KKD) per day), moderately active (EE of 1.5 to 2.9 KKD per day), or sedentary (EE of less than 1.5 KKD per day). More than four in ten (41%) girls reported being sedentary compared to 26% of boys, while 59% of girls and 74% of boys reported being active/moderately active, respectively (Shields, 2005).

Consistent with findings found in the 2004 CCHS, the Canadian Fitness and Lifestyle Research Institute Physical Activity Monitor (Canadian Fitness and Lifestyle Research Institute, 2004) reported physical activity levels using data from the 2002 – 2003 Canadian Community Health Survey Cycle 2.1. The Physical Activity Monitor stated that only half (49%) of Canadian teenagers were active during leisure time which equivocates to at least one hour a day of walking (more than 3 KKD per day). Further, adolescent boys (27%) were more likely than girls (14%) to be active (at both 3+ KKD and 6+ KKD per day). Older adolescents (15 to 19 years) were less likely to be active than younger adolescents (12 to 14 years), demonstrating a decrease in physical activity with age. This trend widened with age, with 55% of girls versus 43% of boys ages 12 to 14 years classified as inactive (at < 3 KKD per day), compared to 63% of girls and 44% of boys at 15 to 19 years (Canadian Fitness and Lifestyle Research Institute, 2004).

Recently (2005 – 2006), the Canadian Fitness and Lifestyle Research Institute conducted the Canadian Physical Activity Levels Among Youth (CANPLAY) Study in over 6,000 children and youth 5 to 19 years. This study found that Canadian youth take an average of 11,356 steps per day as measured using pedometers, with boys taking approximately 1,200 more steps per day than girls (boys = 11,946 steps per day, girls = 10,735 steps per day). Also, physical activity declined with age where children ages 5 to 10 took approximately 1,000 more steps than children ages 11 to 14 (5 to 10 years = 12,353 steps per day, 11 to 14 years = 11,367 steps per day). Adolescents (15 to 19 years) took even fewer steps (9,797 steps per day); roughly 1,500 less than children aged 11 to 14 years (Canadian Fitness and Lifestyle Research Institute, 2006).

Alberta and Ontario physical activity levels are similar to national statistics. In a report by Plotnikoff et al. (2004), only 57% of high school students (mean age = 15.6 years) achieved recommended physical activity levels as based on Canada's Physical Activity Guide to Healthy Active Living (at least 30 minutes of moderate and 20 minutes of vigorous activity at least four days per week) when assessed using a modified version of the Godin Leisure-Time Exercise Questionnaire. In comparison to classifications of very active (EE of 3 or more KKD per day), moderately active (EE of 1.5 to 2.9 KKD per day), or sedentary (EE of less than 1.5 KKD per day), 50% were considered very active, 24% moderately active, and 26% of students were considered sedentary (Plotnikoff et al., 2004).

2.4 Conclusions

There are many ways to assess nutritional intake, physical activity and anthropometry; with the most common field methods utilizing self-reported methodology. Although there are potential errors that can result from utilizing self-report, most methods offer appropriate, practical and cost-effective solutions to collecting comprehensive data in large studies. Further, the increased use of the internet and computers provides an attractive method to assess a large number of individuals across wide geographic areas.

Nationally representative surveys such as the 2004 CCHS have provided insight into the health behaviours of Canadian youth. Results indicate that current intake and physical activity levels are inconsistent with recommendations based on CFGHE, the DRIs, and CPAG. Over half of adolescents surveyed in the 2004 CCHS consumed intakes below the recommendations for Fruits and Vegetables, while nearly two-thirds of boys and over four-fifths of girls were below recommendations for Milk Products. Other meal behaviours such as meal skipping, consumption of foods from the Other Foods category, and consumption of foods away from home (including fast food vendors) were prevalent. Additionally, approximately four in ten girls and over a quarter of boys reported being sedentary. Overall, boys had higher intakes than girls and reported being more physically active.

In conclusion, the research presented in this thesis aims to provide a better understanding of the overall dietary and physical activity behaviours of Canadian youth. This was done using a novel web-based method of surveillance that is an appropriate, efficient and cost-effective method of data collection.

2.5 References

Alberta Learning. (2002). Health and life skills, kindergarten to grade 9 [Electronic Version]. Retrieved December 7, 2006 from http://www.education.gov.ab.ca/k_12/curriculum/bySubject/healthpls/health.pdf.

Alberta Learning. (2005). Career and technology studies [Electronic Version]. Retrieved December 7, 2006 from http://www.education.gov.ab.ca/k%5F12/curriculum/bySubject/cts/foods/fodpos.pdf.

Ball, G. D. C., & Willows, N. D. (2005). Definitions of pediatric obesity. *Canadian Medical Association Journal, 172*(3), 309-310; author reply 310-301.

Bandini, L. G., Must, A., Cyr, H., Anderson, S. E., Spadano, J. L., & Dietz, W. H. (2003). Longitudinal changes in the accuracy of reported energy intake in girls 10-15 y of age. *American Journal of Clinical Nutrition, 78*(3), 480-484.

Baranowski, T. (1988). Validity of self report of physical activity: An information processing approach. *Research Quarterly of Exercise and Sport, 59*, 314-327.

Baranowski, T., & Domel, S. B. (1994). A cognitive model of children's reporting of food intake. *American Journal of Clinical Nutrition, 59*(1 Suppl), 212S-217S.

Baranowski, T., Islam, N., Baranowski, J., Cullen, K. W., Myres, D., Marsh, T., & de Moor, C. (2002). The food intake recording software system is valid among fourth-grade children. *Journal of the American Dietetic Association, 102*(3), 380-385.

Barnett, A., Chan, L. Y. S., & Gruce, I. C. (1993). A preliminary study of the 20-m multistage shuttle run as a predictor of peak VO_2 in Hong Kong Chinese students. *Pediatric Exercise Science, 5*, 42-50.

Barr, S. I. (2006). Applications of Dietary Reference Intakes in dietary assessment and planning. *Applied Physiology, Nutrition and Metabolism, 31*(1), 66-73.

Boreham, C. A., Paliczka, V. J., & Nichols, A. K. (1990). A comparison of the PWC_{170} and 20-MST tests of aerobic fitness in adolescent schoolchildren. *Journal of Sports Medicine and Physical Fitness, 30*(1), 19-23.

Boreham, C. A., Twisk, J., Savage, M. J., Cran, G. W., & Strain, J. J. (1997). Physical activity, sports participation, and risk factors in adolescents. *Medicine and Science in Sports and Exercise, 29*(6), 788-793.

Brener, N. D., Billy, J. O. G., & Grady, W. R. (2003). Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *Journal of Adolescent Health, 33*(6), 436-457.

Brener, N. D., McManus, T., Galuska, D. A., Lowry, R., & Wechsler, H. (2003). Reliability and validity of self-reported height and weight among high school students. *Journal of Adolescent Health, 32*(4), 281-287.

Canadian Fitness and Lifestyle Research Institute. (2004). 2004 Physical Activity Monitor [Electronic Version]. Retrieved December 7, 2006 from http://www.cflri.ca/eng/statistics/surveys/pam2004.php.

Canadian Fitness and Lifestyle Research Institute. (2006). 2005 Physical Activity Monitor [Electronic Version]. Retrieved December 15, 2006 from http://www.cflri.ca/eng/statistics/surveys/pam2005.php.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports, 100*(2), 126-131.

Centers for Disease Control and Prevention. (2006a, March 22, 2006). Physical activity for everyone: Measuring physical activity intensity. from http://www.cdc.gov/nccdphp/dnpa/physical/measuring/index.htm

Centers for Disease Control and Prevention. (2006b, March 22, 2006). Physical activity for everyone: Physical activity terms. from http://www.cdc.gov/nccdphp/dnpa/physical/terms/

Cole, T. J. (1991). Weight-stature indices to measure underweight, overweight and obesity. In J. H. Himes (Ed.), *Anthropometric assessment of nutritional status* (pp. 83-111). New York: Wiley-Liss, Inc.

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal (clinical research ed.), 320*(7244), 1240-1243.

Cooley, D., & McNaughton, L. (1999). Aerobic fitness of Tasmanian secondary school children using the 20-m shuttle run test. *Perceptual and Motor Skills, 88*(1), 188-198.

Crawford, P. B., Obarzanek, E., Morrison, J. G., & Sabry, Z. I. (1994). Comparative advantage of 3-day food records over 24-hour recall and 5-day food frequency validated by observation of 9- and 10-year-old girls. *Journal of the American Dietetic Association, 94*(6), 626-630.

Crocker, P. R. E., Bailey, D. A., Faulkner, R. A., Kowalski, K. C., & McGrath, R. (1997). Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children. *Medicine and Science in Sports and Exercise, 29*(10), 1344-1349.

Deurenberg, P., Kusters, C. S., & Smit, H. E. (1990). Assessment of body composition by bioelectrical impedance in children and young adults is strongly age-dependent. *European Journal of Clinical Nutrition, 44*(4), 261-268.

Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, & Community Health Nurses Association of Canada. (2004). The use of growth charts for assessing and monitoring growth in Canadian infants and children. *Canadian Journal of Dietetic Practice and Research, 65*(1), 22-32.

DiSogra, L., & Glanz, K. (2000). The 5 A day Virtual Classroom: an on-line strategy to promote healthful eating. *Journal of the American Dietetic Association, 100*(3), 349-352.

Eaton, J., & Struthers, C. W. (2002). Using the internet for organizational research: a study of cynicism in the workplace. *CyberPsychology and Behavior, 5*(4), 305-313.

Eston, R. G., Rowlands, A. V., & Ingledew, D. K. (1998). Validity of heart rate, pedometry, and accelerometry for predicting the energy cost of children's activities. *Journal of Applied Physiology, 84*(1), 362-371.

Field, A. E., Peterson, K. E., Gortmaker, S. L., Cheung, L., Rockett, H., Fox, M. K., & Colditz, G. A. (1999). Reproducibility and validity of a food frequency questionnaire among fourth to seventh grade inner-city school children: implications of age and day-to-day variation in dietary intake. *Public Health Nutrition, 2*(3), 293-300.

Flegal, K. M., Ogden, C. L., Wei, R., Kuczmarski, R. L., & Johnson, C. L. (2001). Prevalence of overweight in US children: comparison of US growth charts from the Centers for Disease Control and Prevention with other reference values for body mass index. *American Journal of Clinical Nutrition, 73*(6), 1086-1093.

Flegal, K. M., Tabak, C. J., & Ogden, C. L. (2006). Overweight in children: definitions and interpretation. *Health Education Research, 21*(6), 755-760.

Flood, V., Webb, K., Lazarus, R., & Pang, G. (2000). Use of self-report to monitor overweight and obesity in populations: some issues for consideration. *Australian and New Zealand Journal of Public Health, 24*(1), 96-99.

Freedman, D. S., Serdula, M. K., Srinivasan, S. R., & Berenson, G. S. (1999). Relation of circumferences and skinfold thicknesses to lipid and insulin concentrations in children and adolescents: the Bogalusa Heart Study. *American Journal of Clinical Nutrition, 69*(2), 308-317.

Garriguet, D. (2004). Overview of Canadians' eating habits [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/82-620-MIE2006002.pdf.

Ginsburg, K. R., Slap, G. B., Cnaan, A., Forke, C. M., Balsley, C. M., & Rouselle, D. M. (1995). Adolescents' perceptions of factors affecting their decisions to seek health care. *Journal of the American Medical Association, 273*(24), 1913-1918.

Government of Alberta. (2002). Alberta SuperNet. Retrieved December 10, 2006, from http://www.albertasupernet.ca/

Gray-Donald, K., Jacobs-Starkey, L., & Johnson-Down, L. (2000). Food habits of Canadians: reduction in fat intake over a generation. *Canadian Journal of Public Health, 91*(5), 381-385.

Guenther, P. M., DeMaio, T. J., Ingwersen, L. A., & Berline, M. (1995). *The multiple-pass approach for the 24-hour recall in the Continuing Survey of Food Intakes by Individuals (CSFII) 1994-1996.* Paper presented at the International Conference on Dietary Assessment Methods, Boston, Massachusetts.

Hanning, R., & Health Behaviour Research Group. (2004). University of Waterloo: Food Behaviour Survey.

Hanning, R., Lambraki, I., MacDonald, C., McCargar, L., Health Behaviour Research Group, & Beyond an Apple a Day Research Group. (2004). *A web-based approach to nutritional assessment in schools.* Paper presented at the International Congress of Dietetics, Chicago, Illinois.

Hanning, R. M., Jessup, L., Lambraki, I., MacDonald, C., & McCargar, L. (2003). *A web-based approach to assessment of food intake and behaviour of school children and adolescents.* Paper presented at the Canadian Foundation for Dietetic Research Symposium, Calgary, Alberta.

Health Canada. (1992). Canada's Food Guide to Healthy Eating [Electronic Version]. Retrieved December 7, 2006 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/fg_rainbow-arc_en_ciel_ga_e.pdf.

Health Canada. (2002). Canada's Food Guides from 1942 to 1992 [Electronic Version] from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/fg_history-histoire_ga_e.pdf.

Health Canada. (2003a). Consumer perspectives on healthy eating, summary of quantitative research [Electronic Version]. Retrieved December 7, 2006 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/research-recherche-quantitative_e.pdf.

Health Canada. (2003b, December 15, 2003). Physical Activity Guide: What is it? , from http://www.phac-aspc.gc.ca/pau-uap/paguide/intro.html

Health Canada. (2004). Canada's Guide to Healthy Eating and Physical Activity [Electronic Version]. Retrieved December 7, 2006 from http://www.phac-aspc.gc.ca/guide/alt_formats/guide/pdf/cg-cg_e.pdf.

Health Canada. (2006, September 25, 2006). Using the Food Guide. from http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/res/using_food_guide-servir_guide_alimentaire_e.html

Health Canada. (2007). Eating Well with Canada's Food Guide [Electronic Version]. Retrieved February 8, 2007 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/view_eatwell_vue_bienmang_e.pdf.

Health Canada and the Canadian Society for Exercise Physiology. (1998a). Canada's Physical Activity Guide to Healthy Active Living [Electronic Version]. Retrieved December 7, 2006 from http://www.phac-aspc.gc.ca/pau-uap/fitness/pdf/guideEng.pdf.

Health Canada and the Canadian Society for Exercise Physiology. (1998b). Handbook for Canada's Physical Activity Guide to Healthy Active Living [Electronic Version]. Retrieved December 7, 2006 from http://www.phac-aspc.gc.ca/pau-uap/fitness/pdf/handbook_eng.pdf.

Health Canada and the Canadian Society for Exercise Physiology. (1999). Canada's Physical Activity Guide to Healthy Active Living for Older Adults [Electronic Version]. Retrieved December 7, 2006 from http://www.phac-aspc.gc.ca/pau-uap/fitness/pdf/guide_older.pdf.

Health Canada and the Canadian Society for Exercise Physiology. (2002a). Canada's Physical Activity Guide for Children [Electronic Version]. Retrieved December 7, 2006 from http://www.phac-aspc.gc.ca/pau-uap/paguide/child_youth/pdf/guide_k_en.pdf.

Health Canada and the Canadian Society for Exercise Physiology. (2002b). Canada's Physical Activity Guide for Youth [Electronic Version]. Retrieved December 7, 2006 from http://www.phac-aspc.gc.ca/pau-uap/paguide/child_youth/pdf/guide_y_en.pdf.

Himes, J. H. (1999). Agreement among anthropometric indicators identifying the fattest adolescents. *International Journal of Obesity and Related Metabolic Disorders, 23 Suppl 2*, S18-S21.

Himes, J. H., & Faricy, A. (2001). Validity and reliability of self-reported stature and weight of US adolescents. *American Journal of Human Biology, 13*(2), 255-260.

Himes, J. H., & Roche, A. F. (1982). Reported versus measured adult statures. *American Journal of Physical Anthropology, 58*(3), 335-341.

Houtkooper, L. B., Going, S. B., Lohman, T. G., Roche, A. F., & Van Loan, M. (1992). Bioelectrical impedance estimation of fat-free body mass in children and youth: a cross-validation study. *Journal of Applied Physiology, 72*(1), 366-373.

Institute of Medicine. (1997). *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Washington: National Academy Press.

Institute of Medicine. (1998). *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline*. Washington: National Academy Press.

Institute of Medicine. (2000a). *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. Washington: National Academy Press.

Institute of Medicine. (2000b). *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington: National Academy Press.

Institute of Medicine. (2000c). Dietary Reference Intakes: Applications in Dietary Assessment. Washington: National Academy Press.

Institute of Medicine. (2000d). *Dietary Reference Intakes: Applications in Dietary Assessment*. Washington: National Academy Press.

Institute of Medicine. (2005). *Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*. Washington: National Academy Press.

Jacobs Starkey, L., Johnson-Down, L., & Gray-Donald, K. (2001). Food habits of Canadians: comparison of intakes in adults and adolescents to Canada's food guide to healthy eating. *Canadian Journal of Dietetic Practice and Research, 62*(2), 61-69.

Jacobson, B. H., & DeBock, D. H. (2001). Comparison of Body Mass Index by self-reported versus measured height and weight. *Perceptual and Motor Skills, 92*(1), 128-132.

Janssen, I., Katzmarzyk, P. T., Srinivasan, S. R., Chen, W., Malina, R. M., Bouchard, C., & Berenson, G. S. (2005). Combined influence of body mass index and waist circumference on coronary artery disease risk factors among children and adolescents. *Pediatrics, 115*(6), 1623-1630.

Johnson, R. K., Driscoll, P., & Goran, M. I. (1996). Comparison of multiple-pass 24-hour recall estimates of energy intake with total energy expenditure determined by the doubly labeled water method in young children. *Journal of the American Dietetic Association, 96*(11), 1140-1144.

Katzmarzyk, P. T. (2004). Waist circumference percentiles for Canadian youth 11-18y of age. *European Journal of Clinical Nutrition, 58*(7), 1011-1015.

Kilanowski, C. K., Consalvi, A. R., & Epstein, L. H. (1999). Validation of an electronic pedometer for measurement of physical activity in children. *Pediatric Exercise Science, 11*, 63-68.

Kowalski, K. C., Crocker, P. R. E., & Donen, R. M. (2004). The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) manual [Electronic Version] from http://hkin.educ.ubc.ca/behavioural/PAQ%20manual.pdf.

Kowalski, K. C., Crocker, P. R. E., & Faulkner, R. A. (1997). Validation of the Physical Activity Questionnaire for Older Children. *Pediatric Exercise Science, 9*, 174-186.

Kowalski, K. C., Crocker, P. R. E., & Kowalski, N. P. (1997). Convergent validity of the Physical Activity Questionnaire for Adolescents. *Pediatric Exercise Science, 9*, 342-352.

Kuczmarski, R. J., Ogden, C. L., Grummer-Strawn, L. M., Flegal, K. M., Guo, S. S., Wei, R., Mei, Z., Curtin, L. R., Roche, A. F., & Johnson, C. L. (2000). CDC growth charts: United States. *Advance Data*(314), 1-27.

Kuczmarski, R. J., Ogden, C. L., Guo, S. S., Grummer-Strawn, L. M., Flegal, K. M., Mei, Z., Wei, R., Curtin, L. R., Roche, A. F., & Johnson, C. L. (2002). 2000 CDC Growth Charts for the United States: methods and development. *Vital Health Statistics 11*(246), 1-190.

Kyle, U. G., Bosaeus, I., De Lorenzo, A. D., Deurenberg, P., Elia, M., Gomez, J. M., Heitmann, B. L., Kent-Smith, L., Melchior, J.-C., Pirlich, M., Scharfetter, H., Schols, A. M. W. J., & Pichard, C. (2004). Bioelectrical impedance analysis--part I: review of principles and methods. *Clinical Nutrition, 23*(5), 1226-1243.

Léger, L. A., & Lambert, J. (1982). A maximal multistage 20-m shuttle run test to predict VO2 max. *European Journal of Applied Physiology and Occupational Physiology, 49*(1), 1-12.

Léger, L. A., Mercier, D., Gadoury, C., & Lambert, J. (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports Sciences, 6*(2), 93-101.

Liu, N. Y.-S., Plowman, S. A., & Looney, M. A. (1992). The reliability and validity of the 20-meter shuttle test in American students 12 to 15 years old. *Research Quarterly for Exercise and Sport, 63*(4), 360-365.

Livingstone, M. B., Prentice, A. M., Coward, W. A., Strain, J. J., Black, A. E., Davies, P. S. W., Stewart, C. M., McKenna, P. G., & Whitehead, R. G. (1992). Validation of estimates of energy intake by weighed dietary record and diet history in children and adolescents. *American Journal of Clinical Nutrition, 56*(1), 29-35.

Louie, L., Eston, R. G., Rowlands, A. V., Tong, K. K., Ingledew, D. K., & Fu, F. H. (1999). Validity of heart rate, pedometry, and accelerometry for estimating the energy cost of activity in Hong Kong Chinese boys. *Pediatric Exercise Science, 11*, 229-239.

Mahoney, C. (1992). 20-MST and PWC$_{170}$ validity in non-Caucasian children in the UK. *British Journal of Sports Medicine, 26*(1), 45-47.

Malina, R. M., & Katzmarzyk, P. T. (1999). Validity of the body mass index as an indicator of the risk and presence of overweight in adolescents. *American Journal of Clinical Nutrition, 70*(suppl), 131S-136S.

Matsuzaka, A., Takahashi, Y., Yamazoe, M., Kumakura, N., Ikeda, A., Wilk, B., & Bar-Or, O. (2004). Validity of the multistage 20-m shuttle-run test for Japanese children, adolescents, and adults. *Pediatric Exercise Science, 16*, 113-125.

McVeigh, S. K., Payne, A. C., & Scott, S. (1995). The reliability and validity of the 20-meter shuttle test as a predictor of peak oxygen uptake in Edinburgh school children, age 13 to 14 years. *Pediatric Exercise Science, 7*, 69-79.

National Institutes of Health. (1998). Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults--The Evidence Report. National Institutes of Health. *Obesity Research, 6 Suppl 2*, 51S-209S.

Nusser, S. M., Carriquiry, A. L., Dodd, K. W., & Fuller, W. A. (1996). A semiparametric transformation approach to estimating usual daily intake distributions. *Journal of the American Statistical Association, 91*(436), 1440-1449.

Ogden, C. L. (2004). Defining overweight in children using growth charts. *Maryland Medical Journal, 5*(3), 19-21.

Okasora, K., Takaya, R., Tokuda, M., Fukunaga, Y., Oguni, T., Tanaka, H., Konishi, K., & Tamai, H. (1999). Comparison of bioelectrical impedance analysis and dual energy X-ray absorptiometry for assessment of body composition in children. *Pediatrics International, 41*(2), 121-125.

Ontario Ministry of Education. (2000). The Ontario curriculum, grades 11-12, Health and physical education [Electronic Version]. Retrieved December 7, 2006 from http://www.edu.gov.on.ca/eng/curriculum/secondary/health1112curr.pdf.

Ontario Ministry of Education. (2005). The Ontario curriculum, grades 1-8, Health and physical education [Electronic Version]. Retrieved December 7, 2006 from http://www.edu.gov.on.ca/eng/curriculum/elementary/health18curr.pdf.

Ozdoba, R., Corbin, C., & Masurier, G. L. (2004). Does reactivity exist in children when measuring activity levels with unsealed pedometers? *Pediatric Exercise Science, 16*, 158-166.

Palta, M., Prineas, R. J., Berman, R., & Hannan, P. (1982). Comparison of self-reported and measured height and weight. *American Journal of Epidemiology, 115*(2), 223-230.

Phillips, S., Jacobs Starkey, L., & Gray-Donald, K. (2004). Food habits of Canadians: food sources of nutrients for the adolescent sample. *Canadian Journal of Dietetic Practice and Research, 65*(2), 81-84.

Pietrobelli, A., Faith, M. S., Allison, D. B., Gallagher, D., Chiumello, G., & Heymsfield, S. B. (1998). Body mass index as a measure of adiposity among children and adolescents: a validation study. *Journal of Pediatrics, 132*(2), 204-210.

Plotnikoff, R. C., Bercovitz, K., & Loucaides, C. A. (2004). Physical activity, smoking, and obesity among Canadian school youth. Comparison between urban and rural schools. *Canadian Journal of Public Health, 95*(6), 413-418.

Power, C., Lake, J. K., & Cole, T. J. (1997). Measurement and long-term health risks of child and adolescent fatness. *International Journal of Obesity and Related Metabolic Disorders, 21*(7), 507-526.

Rhodes, S. D., Bowie, D. A., & Hergenrather, K. C. (2003). Collecting behavioural data using the world wide web: considerations for researchers. *Journal of Epidemiology and Community Health, 57*(1), 68-73.

Robinson, E. M., Watson, P. D., Clark, T. C., Ameratunga, S. N., Denny, S. J., Adair, V., Crengle, S. M., Dixon, R. S., Fa'asisila, M., Merry, S. N., & Sporle, A. A. (2002). *The development and administration of a population based Multimedia Computer Assisted Self Interview (M-CASI) adolescent health survey.* Paper presented at The International Conference on Improving Surveys, University of Copenhagen, Denmark.

Rockett, H. R. H., Breitenbach, M., Frazier, A. L., Witschi, J., Wolf, A. M., Field, A. E., & Colditz, G. A. (1997). Validation of a youth/adolescent food frequency questionnaire. *Preventive Medicine, 26*(6), 808-816.

Rockett, H. R. H., & Colditz, G. A. (1997). Assessing diets of children and adolescents. *American Journal of Clinical Nutrition, 65*(4 Suppl), 1116S-1122S.

Rockett, H. R. H., Wolf, A. M., & Colditz, G. A. (1995). Development and reproducibility of a food frequency questionnaire to assess diets of older children and adolescents. *Journal of the American Dietetic Association, 95*(3), 336-340.

Rolland-Cachera, M. F., Deheeger, M., Guilloud-Bataille, M., Avons, P., Patois, E., & Sempe, M. (1987). Tracking the development of adiposity from one month of age to adulthood. *Annals of Human Biology, 14*(3), 219-229.

Rowland, M. L. (1990). Self-reported weight and height. *American Journal of Clinical Nutrition, 52*(6), 1125-1133.

Rutishauser, I. H. E. (2005). Dietary intake measurements. *Public Health Nutrition, 8*(7A), 1100-1107.

Shields, M. (2005). Measured obesity: Overweight Canadian children and adolescents [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/2005001/pdf/cobesity.pdf.

Siervogel, R. M., Roche, A. F., Guo, S. M., Mukherjee, D., & Chumlea, W. C. (1991). Patterns of change in weight/stature from 2 to 18 years: findings from long-term serial data for children in the Fels longitudinal growth study. *International Journal of Obesity, 15*(7), 479-485.

Sirard, J. R., & Pate, R. R. (2001). Physical activity assessment in children and adolescents. *Sports Medicine, 31*(6), 439-454.

Statistics Canada. (2003). Household internet use survey - microdata user's guide [Electronic Version] from http://www.statcan.ca/english/freepub/56M0002GIE/56M0002GIE2004001.pdf.

Strauss, R. S. (1999). Comparison of measured and self-reported weight and height in a cross-sectional sample of young adolescents. *International Journal of Obesity and Related Metabolic Disorders, 23*(8), 904-908.

Supple, A. J., Aquilino, W. S., & Wright, D. L. (1999). Collecting sensitive self-report data with laptop computers: Impact on the response tendencies of adolescents in a home interview. *Journal of Research on Adolescence, 9*(4), 467-488.

Tomkinson, G. R., Leger, L. A., Olds, T. S., & Cazorla, G. (2003). Secular trends in the performance of children and adolescents (1980-2000): an analysis of 55 studies of the 20m shuttle run test in 11 countries. *Sports Medicine, 33*(4), 285-300.

Tudor-Locke, C., & Bassett, D. R., Jr. (2004). How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Medicine, 34*(1), 1-8.

Tudor-Locke, C., Pangrazi, R. P., Corbin, C. B., Rutherford, W. J., Vincent, S. D., Raustorp, A., Tomson, L. M., & Cuddihy, T. F. (2004). BMI-referenced standards for recommended pedometer-determined steps/day in children. *Preventive Medicine, 38*(6), 857-864.

Tudor-Locke, C., Williams, J. E., Reis, J. P., & Pluto, D. (2002). Utility of pedometers for assessing physical activity: convergent validity. *Sports Medicine, 32*(12), 795-808.

Tudor-Locke, C., Williams, J. E., Reis, J. P., & Pluto, D. (2004). Utility of pedometers for assessing physical activity: construct validity. *Sports Medicine, 34*(5), 281-291.

Veugelers, P. J., Fitzgerald, A. L., & Johnston, E. (2005). Dietary intake and risk factors for poor diet quality among children in Nova Scotia. *Canadian Journal of Public Health, 96*(3), 212-216.

Vincent, S. D., & Pangrazi, R. P. (2002). Does reactivity exist in children when measuring activity levels with pedometers? *Pediatric Exercise Science, 14*, 56-63.

Wang, J., Thornton, J. C., Bari, S., Williamson, B., Gallagher, D., Heymsfield, S. B., Horlick, M., Kotler, D., Laferrere, B., Mayer, L., Pi-Sunyer, F. X., & Pierson, R. N., Jr. (2003). Comparisons of waist circumferences measured at 4 sites. *American Journal of Clinical Nutrition, 77*(2), 379-384.

Wang, J., Thornton, J. C., Kolesnik, S., & Pierson, R. N., Jr. (2000). Anthropometry in body composition. An overview. *Annals of the New York Academy of Sciences, 904*, 317-326.

Webb, P. M., Zimet, G. D., Fortenberry, J. D., & Blythe, M. J. (1999). Comparability of a computer-assisted versus written method for collecting health behavior information from adolescent patients. *Journal of Adolescent Health, 24*(6), 383-388.

Welk, G. J., Corbin, C. B., & Dale, D. (2000). Measurement issues in the assessment of physical activity in children. *Research Quarterly for Exercise and Sport, 71*(2 Suppl), S59-S73.

Willett, W. (1998). *Nutritional epidemiology* (2nd ed.). New York: Oxford University Press.

Chapter 3: Literature Review of Adolescent Overweight and Obesity in Canada

3.1 Introduction

There has been a dramatic increase in the prevalence of overweight and obesity worldwide. According to the World Health Organization, over 1.6 billion adults (15 years or older) are overweight, while 400 million are obese worldwide. It is projected that by the year 2015, 2.3 billion adults will be overweight and 700 million will be obese (World Health Organization, 2006). This rising epidemic is not limited to specific age groups, socioeconomic groups, or even developed countries. Obesity is being observed virtually everywhere, and affecting the health of individuals worldwide. Overweight and obesity have been linked to increased risk of non-communicable diseases such as type 2 diabetes, cardiovascular disease, and certain forms of cancer which all result in numerous health complications (World Health Organization, 2007).

The obesity epidemic is of concern in Canadian children and adolescents, as overweight and obese children are likely to become obese adults, at risk for numerous health problems (Tjepkema, 2005). The health of Canadian youth is of tremendous interest, however prior to the 2004 Canadian Community Health Survey (CCHS), height and weight had not been measured in a nationally representative sample of Canadian youth (2 to 17 years) since the 1978 – 1979 Canada Health Survey. Although the Canada Fitness Survey was a nationally representative survey, data were not collected on young children less than 7 years. Furthermore, assessment methodologies used to define overweight and obesity have been inconsistent among researchers creating many different prevalence estimates among populations. Therefore, the purpose of this review was to describe the prevalence, determinants, and health consequences of obesity, with specific focus on adolescent overweight and obesity in Canada.

3.2 Definition of Overweight and Obesity in Adolescents

Overweight and obesity are terms that are frequently used interchangeably, however they are separate conditions. Overweight indicates excess body weight for height, while obesity indicates excess adipose tissue (Troiano & Flegal, 1999). In the literature, overweight and obesity are defined using many different methods; however, measures of weight-for-height, specifically Body Mass Index (BMI), are most commonly used. Development of the 2000 Centers for Disease Control and Prevention (CDC) growth charts, and the International Obesity Task Force (IOTF) cut-offs have been previously discussed (section 2.2.3.1). Dietitians of Canada, the Canadian Paediatric Society, the College of Family Physicians of Canada, and the Community Health Nurses Association of Canada recommend the use of the 2000 CDC growth charts in clinical and community settings, and the IOTF cut-offs in group comparisons of overweight and obesity in youth (Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, & Community Health Nurses Association of Canada, 2004).

3.3 Prevalence Data of Overweight and Obesity in Canadian Adolescents

Over the 25 year period from 1978/1979 to 2004 prevalence of overweight and obesity in Canadian boys and girls dramatically increased. Using IOTF cut-offs, the 2004 CCHS found that among children and adolescents 2 to 17 years, prevalence of overweight increased from 13% to 18% in boys and from 12% to 18% in girls. Increases in obesity were even more dramatic, where prevalence increased from 4% to 9% in boys, and from 3% to 7% in girls. Although the prevalence estimates of children 2 to 5 years showed virtually no change, there was a substantial difference in prevalence among adolescents 12 to 17 years. Prevalence of overweight nearly doubled from 11% in 1978/1979 to 20% in 2004. Obesity rates tripled from 1978/1979 (3%) to 2004 (9%). This is consistent with the overall increase in average BMI values, where BMI increased from 20.8 to 22.1 over the 25-year period. The 2004 CCHS also assessed differences in obesity rates among provinces. The combined overweight and obesity rate in Alberta (14% overweight and 8% obese), was significantly ($p < 0.05$) below the national rate (26%). Ontario's combined overweight and obesity rate (19% overweight and 9% obese) was not significantly different than the national rate. Rates of overweight and obesity were highest in the Atlantic provinces and generally decreased moving west across the provinces, with Alberta having the lowest rates (Shields, 2005).

Prior to the CCHS, a study by Tremblay, Katzmarzyk and Willms (2002) determined the temporal trends of overweight and obesity in Canadian children using data from 9,156 children (7 to 13 years) participating in the 1981 Canada Fitness Survey and the 1996 National Longitudinal Survey of Children and Youth. Prevalence of overweight increased from 11% and 13% in 1981 to 33% and 27% in 1996 for boys and girls respectively. Prevalence of obesity increased from 2% for both boys and girls in 1981 to 10% in boys and 9% in girls in 1996. Another study by Tremblay and Willms (2000) determined the secular trends in BMI of Canadian children (7 to 13 years) using data from the 1981 Canada Fitness Survey, the 1988 Campbell's Survey on the Well-

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being of Canadians, and the 1996 National Longitudinal Survey of Children and Youth. It was estimated that since 1981, BMI has increased by 0.1 kg/m^2 per year for both boys and girls at most ages. These findings also support a trend towards an increase in overweight and obesity in Canadian children and adolescents.

In addition to the 2004 CCHS, a study by Janssen and colleagues (2004) assessed a nationally representative sample of adolescents (n = 5,890) ages 11 to 16 years using data from the Canadian component of the 2001/2002 World Health Organization Health Behaviour in School-Aged Children Survey. Self-reported height and weight indicated that 18.3% of boys and 13.3% of girls were overweight, while 5.8% of boys and 3.5% of girls were obese (as determined using the IOTF cut-offs). Body Mass Index was greater in boys than girls, and also significantly increased with age, with 11 to 12 year olds having lower BMIs than 13 to 14 year olds, who sequentially had lower BMIs than 15 to 16 year olds (Janssen, Katzmarzyk, Boyce, King, & Pickett, 2004).

3.4 Health Consequences

There are numerous health consequences of childhood and adolescent obesity including multiple risk factors for cardiovascular disease, type 2 diabetes, and persistence of obesity into adulthood. It has been shown that risk factors for diseases such as cardiovascular disease (CVD) and type 2 diabetes tend to cluster. These risk factors (i.e., abdominal obesity, hyperinsulinemia, hypertension, and dyslipidemia), once clustered have been termed the Metabolic Syndrome (Alberti, Zimmet, & Shaw, 2006). Equally concerning are psychosocial consequences such as discrimination and teasing that may occur, which can have a long term affect on self-esteem and body image. Further, obesity presents an enormous burden to our health care system, which is only expected to increase with the dramatic rise in obesity prevalence.

3.4.1 Psychosocial

Some of the most significant problems associated with obesity in youth are those that effect the emotional development of children and adolescents. A landmark study conducted in the 1960s, demonstrated that obese children were regarded by other children as the least desired friends when rank order of preference was compared to children with physical disabilities (Richardson, Hastorff, Goodman, & Dornbusch, 1961). Studies conducted in the 1970s showed that children six years of age believed that overweight individuals could be described as lazy, lying, cheating, sloppy, dirty, ugly and stupid (Caskey & Felker, 1971; Kirkpatrick & Sanders, 1978). A more recent study showed that children 7 to 9 years selected chubby silhouettes as those with the least favourable outcomes, meaning they had more negative attributes (gets teased, lonely, lazy, and ugly) and less positive attributes (kind, best friend, honest, and funny). In this study, children's BMI did not have an effect on their ratings, suggesting that obese and normal weight children may have the same attitudes towards their overweight peers (Kraig & Keel, 2001). Recently, Latner and Stunkard (2003) demonstrated that discrimination against obese children is stronger than it was over 40 years ago. In this study, the difference in liking a healthy (as defined by the authors as no disability) child over an obese child was 40.8% greater between 1961 and 2001.

Teasing among overweight children and adolescents is also a tremendous problem. In a study of 158 youth, obese children and adolescents reported a significantly higher amount of weight-related teasing compared to performance-related teasing. Furthermore, girls in this study perceived the teasing as more stressful (Warschburger, 2005). Although some studies show that obese children have a low self-esteem, other studies show conflicting results. However, it appears that once children become adolescents, obesity has a greater affect on self-esteem, which has been shown to track into adulthood (Dietz, 1998; Must & Strauss, 1999). A study completed in Canadian children 12 years of age showed that self-esteem was lower in students that were classified as obese (BMI > 95th percentile) (Tremblay, Inman, & Willms, 2000).

3.4.2 Cardiovascular Disease

Overweight children and adolescents frequently demonstrate elevated levels of risk factors associated with CVD, and it is known that adiposity in youth has adverse consequences on the cardiovascular system comparable to what is currently being observed in adults (Reilly et al., 2003). Using data from the Bogalusa Heart Study, Freedman et al. (1999) examined 9,157 youth (ages 5 to 17 years) surveyed between 1973 and 1994 and found that the number of risk factors for CVD increased with increased weight. Among 11 to 17 year olds, overweight children (BMI for age greater than the 95th percentile) represented only 10% (216/2214) of the children that had no CVD risk factors. These numbers increased as the number of CVD risk factors increased, with overweight children representing 23% (155/677) of the children with one CVD risk factor, 40% (90/223) of the children with two CVD risk factors, and 70% (50/71) of the children with three or more CVD risk factors. Overweight youth were 9.7 times as likely to have two risk factors, and 43.5 times as likely to have three or more CVD risk factors compared to their normal weight peers. Compared to normal weight youth (BMI for age less than the 85th percentile), overweight youth were 7.1 times as likely to have high levels of triglycerides. Odds ratios for other CVD risk factors included 12.6 (fasting insulin), 4.5 (systolic blood pressure), 3.4 (high-density lipoprotein cholesterol), 3.0 (low-density lipoprotein cholesterol), 2.4 (total cholesterol), and 2.4 (diastolic blood pressure).

Recent findings from the Bogalusa Heart Study indicated that adverse risk factors for metabolic syndrome during childhood and adolescence was predictive of hypertension in adulthood. In this study, normotensive (n = 2,206), prehypertensive (n = 721), and hypertensive (n = 328) adults were studied retrospectively, where subjects were assessed as children (4 to 11 years), adolescents (12 to 18 years) and adults (19 to 42 years). Results indicated that prehypertensive and hypertensive subjects compared to normotensive subjects had higher levels of systolic blood pressure, diastolic blood pressure, adiposity (BMI and subscapular skinfold), and triglycerides during childhood, adolescence and adulthood. Glucose levels were also significantly higher between hypertensive and normotensive subjects during childhood, adolescence and adulthood. Significant differences between hypertension status were also observed for insulin levels, low-density lipoprotein (LDL) cholesterol and high-density lipoprotein (HDL) cholesterol, although these differences did not exist for all age groups (Srinivasan, Myers, & Berenson, 2006).

Consistent with results from the Bogalusa Heart Study, autopsy studies have shown that atherosclerosis exists in adolescents, and researchers have even identified fatty streaks in the aorta of children as young as 3 years of age. This suggests that atherosclerosis begins in childhood (Burke, 2006). Although cross-sectional studies provide important information, longitudinal studies provide critical information regarding the persistence of childhood CVD risk into adulthood. Webber and colleagues (1991) showed that 50% of children (n = 1,586) with high total cholesterol and low-density lipoprotein cholesterol levels (above the 75th percentile) at baseline had elevated levels 12 years later. In the Harvard Growth Study, 508 adolescents were followed over time to assess all-cause and cardiovascular mortality and morbidity. In this study, men that were overweight as adolescents had an increased risk of mortality from coronary heart disease (relative risk = 2.3), while morbidity associated with coronary heart disease was increased for both men and women (Must, Jacques, Dallal, Bajema, & Dietz, 1992). Other studies have shown similar results, where overweight and obesity during childhood or adolescence led to greater risk of all-cause or cardiovascular morbidity or mortality in adulthood (Ball & McCargar, 2003; Bao, Srinivasan, Wattigney, & Berenson, 1994; Gunnell, Frankel, Nanchahal, Peters, & Davey Smith, 1998; Must & Strauss, 1999).

3.4.3 Type 2 Diabetes

According to the Canadian Diabetes Association (2003), "Diabetes mellitus is a metabolic disorder characterized by the presence of hyperglycemia due to defective insulin secretion, insulin action or both" (p. S7). Historically, type 2 diabetes was thought to occur only in adults; however, a new epidemic is emerging as type 2 diabetes is being diagnosed at younger ages, concurrent with increases in childhood and adolescent obesity (Brosnan, Upchurch, & Schreiner, 2001). The majority of children with type 2 diabetes are overweight or obese which is contributing to the increased prevalence of type 2 diabetes in youth (Botero & Wolfsdorf, 2005; Cara & Chaiken, 2006; Weiss, Taksali, & Caprio, 2006). In addition to overweight and obesity, other risk factors for type 2 diabetes include increased abdominal fat, family history of type 2 diabetes, impaired glucose tolerance, polycystic ovary syndrome, acanthosis nigricans, hypertension, dyslipidemia, exposure to diabetes in utero (gestational diabetes), and being a member of a high-risk population (Aboriginal, Hispanic, South Asian, African) (Canadian Diabetes Association, 2003; Goran, Ball, & Cruz, 2003). Although the predominant form of diabetes in children and adolescents is type 1 diabetes, it is expected that within 10 years, type 2 diabetes will surpass type 1 diabetes in many ethnic groups (Alberti et al., 2004).

In Canada, prevalence of type 2 diabetes has been dramatically increasing in Aboriginal children. A study done by Young et al. (2000) in an Ojibwa-Cree community in northern Manitoba determined that overweight children (greater than or equal to the 85th percentile) were more likely to have impaired glucose tolerance or diabetes (odds ratio = 5.1) than normal weight children (less than the 85th percentile). This is of concern, as 60% of boys and 64% of girls (4 to 19 years) exceeded the 85th percentile for BMI reference values. Other studies in Canadian aboriginal children (5 to 18 years) have estimated the prevalence of type 2 diabetes to be as high as 1% (2.5/1,000 in 1994) with over 70% of children classified as obese (BMI > 95th percentile) (Canadian Diabetes Association, 2003; Harris, Perkins, & Whalen-Brough, 1996).

Many cases of type 2 diabetes in children and adolescents may be undiagnosed. Researchers examining NHANES III estimated that nearly one third of adults may have undiagnosed type 2 diabetes, and it is likely that undiagnosed diabetes also exists in youth (Bobo et al., 2004). Furthermore, it is often difficult to differentiate between type

1 and type 2 diabetes in children and adolescents, which is frustrating for many youth and their families (Canadian Diabetes Association, 2003).

Type 2 diabetes is of great concern when diagnosed at a young age. Children and adolescents are at risk of developing micro- and macrovascular complications for a much longer period of time given the early age of diagnosis. Therefore, many diabetic youth will suffer complications throughout peak periods of their life including early adulthood. In a Canadian study, 51 young adults (18 to 33 years) who had been diagnosed with type 2 diabetes during their childhood were surveyed on diabetes-related medical complications. From the time of diagnosis to early adulthood, one had developed blindness, another had an amputation, 6% were on dialysis and 9% had died (Dean & Flett, 2002). Therefore, it is essential that individuals who develop type 2 diabetes during childhood or adolescence follow a multi-disciplinary approach to diabetes management. However, adolescence is a time of increased independence and autonomy, which often leads to a lack of compliance with medical treatment (Brosnan et al., 2001). This puts a strain on both the patient and the entire family (Brosnan et al., 2001). Due to lack of medical treatment compliance, the considerable health and psychosocial complications associated with type 2 diabetes, and the tracking of these complications into adulthood, prevention plays a key role in reducing the risk of diabetes in this population. Obesity is a modifiable risk factor for type 2 diabetes, and it is assumed that a reduction in the prevalence of overweight and obesity would parallel a decrease in the prevalence of type 2 diabetes in youth (Canadian Diabetes Association, 2003; Cara & Chaiken, 2006).

3.4.4 Obesity Persistence into Adulthood

Obesity has been shown to track into adulthood, especially among adolescents. Various studies have examined the persistence of obesity into adulthood including the Fels Longitudinal Study (baseline data collected from individuals born between 1929 - 1960) and the Bogalusa Heart Study (data collection during 1973 – 1974 and 1992 – 1994). Participants in the Fels Longitudinal Study (male, n = 166; female, n = 181) were assessed in terms of BMI at 3 to 20 years of age, and then again at 30 to 39 years of age. In this study, children and adolescents with a BMI greater than the 95th percentile at baseline had a 62% to 98% likelihood of being overweight at the age of 35 years. The risk of adiposity in adulthood also increased with increased age at baseline. In other words, overweight or obesity during adolescence was more likely than overweight or obesity during childhood to track into adulthood (Guo, Wu, Chumlea, & Roche, 2002).

Findings from the Bogalusa Heart Study support the work done by Guo and colleagues. Children (n = 2,610) living in Bogalusa, Louisiana were assessed at 2 to 17 years and then again during early adulthood (18 to 37 years). Body Mass Index and triceps skinfold thickness during childhood were associated with adult BMIs and adiposity (overall spearman correlations ranged from 0.44 to 0.64). As seen in the Fels Longitudinal Study, the association between childhood BMI and adult adiposity increased with childhood age, however it should be noted that correlations, although modest, were seen as young as 2 to 5 years of age (Freedman et al., 2005). Earlier studies, including the Muscatine Study (Lauer, Lee, & Clarke, 1988), and studies by Whitaker et al. (1997) and Serdula et al. (1993) also showed the tracking of obesity into adulthood. Although some studies have shown only modest correlations, it can be concluded that many overweight and obese adolescents will become obese adults, at risk for numerous health problems, including type 2 diabetes, cardiovascular disease, high blood pressure, osteoarthritis, gallbladder disease, and some forms of cancer (Tjepkema, 2005). Furthermore, overweight and obese adolescents are at an even greater risk of persistence of obesity into adulthood leading to long-term consequences of obesity and obesity-related disorders.

3.4.5 Cost of Obesity

Obesity places a major economic burden on the Canadian health care system. Obesity is the most common metabolic condition in industrialized nations, and is associated with risk factors for a number of non-communicable diseases such as hypertension, type 2 diabetes, cardiovascular disease, dyslipidemia, gallbladder disease and cancer. Given the high prevalence of obesity and associated health consequences in Canada, the direct cost of obesity is substantial. Using cost-of-illness studies, the direct cost (hospital care, services from physicians and other health professionals, drugs, research and other health care) of obesity in 1997 was calculated at over $1.8 billion, or 2.4% of the total health care expenditures in Canada (Birmingham, Muller, Palepu, Spinelli, & Anis, 1999). The largest contributors were from hypertension ($656.6 million), type 2 diabetes ($423.2 million), and coronary artery disease ($346.0 million). The population attributable fractions (PAF) for obesity were calculated to determine how obesity contributed to each condition. Type 2 diabetes had the highest PAF at 50.7%, followed by hypertension at 31.6% and coronary artery disease at 17.9% (Birmingham et al., 1999).

A more recent study estimated the economic burden of physical inactivity and obesity in 2001 at $5.3 billion ($1.6 billion in direct costs and $3.7 billion in indirect costs) and $4.3 billion ($1.6 billion in direct costs and $2.7 billion in indirect costs) respectively (Katzmarzyk & Janssen, 2004). These costs represented 2.6% (physical inactivity) and 2.2% (obesity) of the total health care expenditures in Canada. The population attributable risks (PAR) were calculated, with stroke (24.3%) having the highest PAR for physical inactivity, while hypertension (34.0%) had the highest PAR for obesity (Katzmarzyk & Janssen, 2004).

3.5 Determinants of Adolescent Obesity

Obesity is a complex condition involving individual/behavioural, environmental and social factors; however it has been proposed that a basic imbalance of energy intake and energy expenditure leads to increased adiposity (Ruvession & Tataranni, 1997). Specifically, individual behaviours such as increased consumption of high calorie foods, decreased physical activity, and increased sedentary activity have been identified as key issues in the development of obesity. Although genetics plays a role in the development of obesity, it is considered unlikely that genetics alone could lead to the dramatic increase in prevalence of overweight and obesity that has been observed recently. It is known that obesity is a result of a basic imbalance of the energy expenditure equation; however gene-environment interactions especially within "obesogenic" environments help to explain the rapid increase in obesity worldwide. As part of an ecological framework within the population health perspective, environmental and social determinants provide insight into the etiology of obesity (Raine, 2004).

3.5.1 Nutrition

Although it is widely accepted that physical activity has decreased among the adolescent population, there is conflicting evidence regarding changes in nutrient intakes. This could potentially be explained by methodological differences. Several researchers have suggested that an increase in dietary fat intake, not dietary energy intake can be correlated to an increase in body fat in children ages 4 to 11 years (Gazzaniga & Burns, 1993; Maffeis, Pinelli, & Schutz, 1996; Nguyen, Larson, Johnson, & Goran, 1996; Obarzanek et al., 1994; Tucker, Seljaas, & Hager, 1997), while Gillis and colleagues (2002) demonstrated a stronger effect between dietary energy intake and obesity among children and adolescents. Further, an additional study showed a decrease in dietary fat intake and little change in energy intake despite an increase in the prevalence of overweight (Troiano, Briefel, Carroll, & Bialostosky, 2000).

Within the Canadian population, trends can be observed by examining results from the 2004 CCHS in comparison to the 1970 – 1972 Nutrition Canada Survey. Although methodological issues exist when comparing these two databases such as differences in response rates, and data collection procedures, both were national surveys that were based on individuals' recall of food intake the day prior to the survey. In comparison to data collected in 1970 – 1972, total caloric intake decreased over time in 5 to 11 year old boys and girls (1970 – 1972 = 2,300 kcals/day; 2004 = 2,041 kcals/day). This trend was similar in adolescent boys ages 12 to 19 years (1970 – 1972 = 3,251 kcals/day; 2004 = 2,806 kcals/day), although mean differences were not as large in girls of the same age (1970 – 1972 = 2,242 kcals/day; 2004 = 2,047 kcals/day). Differences in fat intake as expressed as a percentage of calories from fat showed an even more dramatic decrease over time with children ages 5 to 11 showing decreases from 38% (1970 – 1972) to 30.5% (2004). Adolescents' intakes decreased by nearly 10% for both boys (1970 – 1972 = 41%; 2004 = 31.3%) and girls (1970 – 1972 = 40%; 2004 = 30.8%) (Garriguet, 2004). Although this trend appears contradictory to the increase in overweight and obesity rates over time, one explanation can be provided by the social desirability phenomenon. As individuals became more aware of recommendations to decrease fat intake, consuming foods high in fat becomes less socially desirable. When individuals are affected by social desirability, they feel the need to provide others with a favourable impression of oneself (Brener, Billy, & Grady, 2003). This can lead to intentional omission of foods deemed socially unacceptable or "unhealthy" by the subject.

As part of the 2004 CCHS, heights and weights were directly measured in a nationally representative sample of all Canadians. Because the 2004 CCHS also examined nutritional intakes, overweight and obesity status can be compared to nutritional intakes. Analysis of the 2004 CCHS data showed that 59% of children and adolescents reported consuming fruits and vegetables less than five times per day. Individuals that consumed fruits and vegetables less than 3 times a day (21%) or 3 to less than 5 times per day (37%) were more likely than those who consumed fruits and vegetables more frequently (5 or more times a day) to be classified as overweight/obese or obese (Shields, 2005). Beverage consumption was also assessed in the 2004 CCHS due to observed increases in soft drink consumption, and decreases in milk consumption among youth. This trend in beverage consumption has potentially negative consequences in terms of obesity (increases in added sugar consumption) and growth (decreases in milk consumption). Not surprisingly, results from the 2004 CCHS indicated the top caloric contributor in the Other Foods category for all age groups was from soft drink consumption, with 11% of Other Foods kilocalories coming from soft drinks. Further, intakes of Milk Products were below recommended levels for boys and girls 9 to 18 years of age (Garriguet, 2004). The low levels of Milk Product consumption can potentially be explained by both compensatory behaviours in beverage intake (i.e. high calorie beverages) and a high prevalence of breakfast skipping in this population (Affenito et al., 2005). When surveyed, approximately 10% of individuals reported skipping breakfast the day before they were interviewed. Among children and adolescents, approximately 17% of kilocalories came from breakfast, in comparison to 24% at lunch, 31% at dinner and 27% at other times. Furthermore, approximately one-third of adolescents reported consuming food prepared at a fast food outlet (Garriguet, 2004).

In the United States, data from the National Heart, Lung, and Blood Institute Growth and Health Survey assessed longitudinal changes in beverage consumption among 2,371 girls. Girls were assessed initially at age 9 or 10 years and annually up until 19 years of age. Data from multiple 3-day food records indicated that milk consumption decreased by over 25% over the ten year period, while regular soft drink consumption nearly tripled. It was estimated that the increased prevalence of breakfast skipping, in part, led to the decrease in milk consumption over time. In this study, regular soft drink consumption was also associated with significant decreases in calcium intake. Further, for every 100 grams of regular soft drinks consumed, BMI increased by 0.01 unit and average daily caloric intake increased by approximately 82 kilocalories (Striegel-Moore et al., 2006). While 82 kilocalories may not necessarily seem significant, data from NHANES III (1988 – 1994) and NHANES 1999 – 20002 indicated that a reduction in energy intake of 110 – 165 kilocalories/day could have helped prevent the increase in excess weight (0.43 kg/year) observed over the 10 year period in American children and adolescents (Wang, Gortmaker, Sobol, & Kuntz, 2006). A study done by Ebbeling and colleagues (2006) showed that a 25-week intervention in adolescents aged 13 to 18 years was able to decrease sugar-sweetened beverage consumption by 82% when compared to controls. Further, individuals at the highest BMI tertile showed significant average BMI changes between the intervention (- 0.63 kg/m^2) and control (+ 0.12 kg/m^2) groups.

Over the past 50 years, serving sizes of soft drinks have considerably increased. In the 1950s, a single-serving soft drink bottle was only 6.5 ounces, whereas in 2000 the typical single-serving soft drink bottle was 20 ounces. Further, fast food restaurants have been marketing super size meals which include beverages up to 42 ounces (French, 2003). This increase in single-serving sizes makes it relatively easy to consume an additional 110 – 165 kilocalories from soft drinks each day.

3.5.2 Physical Activity

Recent findings from the 2004 CCHS indicated that physical inactivity is common among children and adolescents. However, it is the association between physical activity and overweight/obesity that is of interest. Although it would be expected that activity levels would be strongly associated with weight status, this was not seen in children ages 6 to 11 years. However, adolescent boys showed significant associations where sedentary boys were more likely than active boys to be obese. While 16% of sedentary boys were obese, only 9% of active boys were obese. (Shields, 2005)

Stronger associations were seen when examining screen time activity in the 2004 CCHS. Screen time activities are becoming extremely common among Canadian children and adolescents and include activities such as playing video games, watching television, and using the computer. In 2004, 36% of Canadian children ages 6 to 11 years reported over 2 hours of daily screen time. Those children whose screen time exceeded two hours per day were twice as likely to be overweight/obese (35% versus 18%) and obese (11% versus 5%) compared to children whose screen time was less than one hour per day. Among adolescents 12 to 17 years, increases in weekly screen time paralleled increases in rates of overweight/obesity. While 23% of adolescents who logged 10 hours or less of screen time were overweight/obese, this figure significantly increased among those that logged 20 hours to less than 30 hours per week (31% overweight/obese) and 30 or more hours per week (35% overweight/obese). Although it is difficult to compare these results to previous studies due to increases in video game and computer screen time, the Campbell's Survey on Health and Well-being calculated the weekly average of television viewing among adolescents 12 to 17 years at 9 hours. This is comparable to the 10 hours of weekly television viewing in 2004; however, the addition of video games and computers doubles the average to 20 hours per week (Shields, 2005).

3.5.3 Obesogenic Environment

The term "obesogenic environment" was coined by Swinburn and colleagues and is defined as "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations" (Swinburn, Egger, & Raza, 1999, p. 564). The ANGELO framework (Analysis Grid for Environments Linked to Obesity) was used to explain obesogenicity of environments using a 2 x 4 grid which dissects the environment into size (micro and macro) and type (physical, economic, political, and sociocultural). Conceptually, this framework not only helps to explain obesogenic environments, but is also key in prioritizing environmental interventions (Swinburn et al., 1999). Although it is beyond the scope of this review to describe all possible environmental interactions, key issues surrounding obesity in adolescents involve home and school environments, and accessibility to fast food and physical activity.

Data from NHANES III indicated that over 83% of adolescents (ages 12 to 16 years) whose parents' were normal weight, were also classified as normal weight themselves. Only 57% of adolescents with one or two obese parents were classified as normal weight. Although results from this study suggest a genetic predisposition to obesity, it must be noted that many environmental interactions also exist. Of particular interest was the observed protective effect of breakfast eating against obesity status in youth. Adolescents that consumed breakfast every day or even on some days were significantly protected against overweight if they had one or more obese parents (Fiore, Travis, Whalen, Auinger, & Ryan, 2006).

The importance of family meals, home environments and fast food availability was demonstrated in Project EAT (Eating Among Teens), a study done in 4,746 middle and high school students living in the United States. Students that consumed family meals more frequently had higher intakes of fruits, vegetables, grains, and calcium-rich foods. Further, frequency of family meals was negatively correlated with soft drink consumption (Neumark-Sztainer, Hannan, Story, Croll, & Perry, 2003). Data from the same study indicated that frequency of fruit and vegetable consumption was most strongly correlated with home availability (Neumark-Sztainer, Wall, Perry, & Story, 2003), whereas calcium intakes of both boys and girls were significantly positively associated with availability of milk at meals and eating breakfast, and significantly negatively associated with fast food consumption and intake of soft drinks (boys) (Larson, Story, Wall, & Neumark-Sztainer, 2006). Frequency of fast food consumption was found to be associated with higher intakes of total energy, percent energy from fat, daily servings of soft drinks, and lower intakes of fruit, vegetables and milk (French, Story, Neumark-Sztainer, Fulkerson, & Hannan, 2001).

In addition to the home environment, the school environment is an important determinant of student food and activity choices. A study done by Neumark-Sztainer and colleagues assessed the impact of school food policies on lunch and vending machine purchases. In this study, the number of foods purchased from vending machines significantly increased with increased numbers of vending machines present in the school. Further, students in schools where the soft drink machines were turned off during lunch time consumed significantly less soft drinks than those students who attended schools where the soft drink machines were turned on during lunch time (0.5 days/week versus 0.9 days/week) (Neumark-Sztainer, French, Hannan, Story, & Fulkerson, 2005).

In Alberta, various initiatives have been launched to help improve school environments. For example, as of September of 2005, all grade 1 – 9 Alberta students are required to complete 30 minutes of Daily Physical Activity (DPA) (Alberta Education, 2007). Although daily physical activity has many benefits to child and adolescents, the specific benefits of the Alberta DPA initiative have not yet been reviewed. Further, DPA has not been implemented in grades 10 through 12. However, a review of physical activity in high schools is currently underway. In a study done by Plotnikoff and colleagues (2004), physical activity and obesity status were assessed in 2,697 high school students attending either a rural or urban school in Alberta and Ontario. Although there was no difference in physical activity status between students attending schools in rural and urban areas, boys in rural areas were more likely to be overweight than boys in urban areas, whereas girls in rural areas were more likely to be obese compared to their peers in urban areas. One explanation for this finding is the likelihood that rural areas have more limited numbers of recreation facilities compared to urban areas (Plotnikoff et al., 2004).

3.5.4 Socioeconomic Status

Socioeconomic status can be examined by looking at income, education and employment. Analysis of the 2004 CCHS data showed that children and adolescents that were part of a middle-income household were more likely to be overweight/obese than those living in a high-income household (29% versus 23%). In this study, high income was defined as a household income of $60,000 or more (1 or 2 people) or $80,000 or more (3 or more people); while middle income was defined as a household income ranging from $10,000 to $79,999, depending on the number of individuals living in the household. The 2004 survey also examined the association between education and weight status. Youth living in a household where the highest level of education was secondary graduation (or less) were more likely to be overweight/obese than their peers living in households where the highest level of education was postsecondary graduation (31% versus 25%) (Shields, 2005).

The University of Waterloo Food Behaviour Questionnaire was used by Minaker and colleagues (2006) to analyze differences in food behaviours as described by school region socioeconomic status and geographic location. As school region socioeconomic status increased (incomes ranged from $40,959 to $85,922 per year), levels of fruit and vegetable consumption, fibre intake and frequency of breakfast eating also significantly increased. The consumption of added sugar significantly decreased with increased income. Each $10,000 increase in school region socioeconomic status was positively correlated with mean intakes of fruits and vegetables (0.33 serving increase per $10,000) and fibre (0.8 gram increase per $10,000) and negatively correlated with added sugar (3.3 gram decrease per $10,000). It was also found that students attending private school had lower intakes of sweetened drinks and higher intakes of fibre than their peers attending public school. Further, students living in rural areas had significantly higher intakes of calcium and milk products compared to those living in urban areas (Minaker et al., 2006). Similarly, adolescents living in lower-SES neighbourhoods are less physically active and at greater risk of being overweight (Gordon-Larsen, Nelson, Page, & Popkin, 2006; Janssen, Boyce, Simpson, & Pickett, 2006). Although the relationship between socioeconomic status and overweight/obesity results from many complex mechanisms, these studies provide important insight into the determinants of adolescent overweight and obesity.

3.6 Conclusions

Over the 25 year period from 1978/1979 to 2004 prevalence of overweight and obesity in Canadian children and adolescents has dramatically increased. This is disconcerting as obesity is linked to numerous health consequences including type 2 diabetes, cardiovascular disease, and tracking of obesity into adulthood. Of equal concern are the psychosocial implications of obesity which can have a lasting impact on children and adolescents.

Obesity is a multifaceted condition involving individual/behavioural, environmental and social factors. However, it has been proposed that a basic imbalance of energy intake and energy expenditure leads to increased adiposity. Nutrition, physical activity, obesogenic environments, and socioeconomic status are all important determinants of obesity that interact in a complex way with many underlying physiological mechanisms. Further, obesity presents an enormous burden to our health care system, which is only expected to increase concurrent with the dramatic rise in obesity prevalence. Therefore the purpose of this research aims to investigate the current overweight and obesity status of Canadian adolescents and identify individual determinants of overweight and obesity such as nutritional intakes, eating behaviours and physical inactivity.

3.7 References

Affenito, S. G., Thompson, D. R., Barton, B. A., Franko, D. L., Daniels, S. R., Obarzanek, E., Schreiber, G. B., & Striegel-Moore, R. H. (2005). Breakfast consumption by African-American and white adolescent girls correlates positively with calcium and fiber intake and negatively with body mass index. *Journal of the American Dietetic Association, 105*(6), 938-945.

Alberta Education. (2007). Daily Physical Activity. Retrieved January 8, 2007, from http://ednet.edc.gov.ab.ca/k_12/curriculum/bysubject/dpa.asp

Alberti, G., Zimmet, P., Shaw, J., Bloomgarden, Z., Kaufman, F., & Silink, M. (2004). Type 2 diabetes in the young: the evolving epidemic: the international diabetes federation consensus workshop. *Diabetes Care, 27*(7), 1798-1811.

Alberti, K. G., Zimmet, P., & Shaw, J. (2006). Metabolic syndrome--a new world-wide definition. A Consensus Statement from the International Diabetes Federation. *Diabetes Medicine, 23*(5), 469-480.

Ball, G. D. C., & McCargar, L. J. (2003). Childhood obesity in Canada: a review of prevalence estimates and risk factors for cardiovascular diseases and type 2 diabetes. *Canadian Journal of Applied Physiology, 28*(1), 117-140.

Bao, W., Srinivasan, S. R., Wattigney, W. A., & Berenson, G. S. (1994). Persistence of multiple cardiovascular risk clustering related to syndrome X from childhood to young adulthood. The Bogalusa Heart Study. *Archives of Internal Medicine, 154*(16), 1842-1847.

Birmingham, C. L., Muller, J. L., Palepu, A., Spinelli, J. J., & Anis, A. H. (1999). The cost of obesity in Canada. *Canadian Medical Association Journal, 160*(4), 483-488.

Bobo, N., Evert, A., Gallivan, J., Imperatore, G., Kelly, J., Linder, B., Lorenz, R., Malozowski, S., Marschilok, C., Minners, R., Moore, K., Perez Comas, A., Satterfield, D., Silverstein, J., Vaughn, G. G., & Warren-Boulton, E. (2004). An update on type 2 diabetes in youth from the National Diabetes Education Program. *Pediatrics, 114*(1), 259-263.

Botero, D., & Wolfsdorf, J. I. (2005). Diabetes mellitus in children and adolescents. *Archives of Medical Research, 36*(3), 281-290.

Brener, N. D., Billy, J. O. G., & Grady, W. R. (2003). Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *Journal of Adolescent Health, 33*(6), 436-457.

Brosnan, C. A., Upchurch, S., & Schreiner, B. (2001). Type 2 diabetes in children and adolescents: An emerging disease. *Journal of Pediatric Health Care, 15*(4), 187-193.

Burke, V. (2006). Obesity in childhood and cardiovascular risk. *Clinical and Experimental Pharmacology and Physiology, 33*(9), 831-837.

Canadian Diabetes Association. (2003). Canadian Diabetes Association 2003 clinical practice guidelines for the prevention and management of diabetes in Canada. *27*(Suppl 2), S1-S152.

Cara, J. F., & Chaiken, R. L. (2006). Type 2 diabetes and the metabolic syndrome in children and adolescents. *Current Diabetes Reports, 6*(3), 241-250.

Caskey, S. R., & Felker, D. W. (1971). Social stereotyping of female body image by elementary school age girls. *Research Quarterly, 42*(3), 251-255.

Dean, H., & Flett, B. (2002). Natural history of type 2 diabetes diagnosed in childhood: Long term follow-up in young adult years. *Diabetes, 51*(Suppl 1), A24.

Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, & Community Health Nurses Association of Canada. (2004). The use of growth charts for assessing and monitoring growth in Canadian infants and children. *Canadian Journal of Dietetic Practice and Research, 65*(1), 22-32.

Dietz, W. H. (1998). Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics, 101*(3), 518-525.

Ebbeling, C. B., Feldman, H. A., Osganian, S. K., Chomitz, V. R., Ellenbogen, S. J., & Ludwig, D. S. (2006). Effects of decreasing sugar-sweetened beverage consumption on body weight in adolescents: a randomized, controlled pilot study. *Pediatrics, 117*(3), 673-680.

Fiore, H., Travis, S., Whalen, A., Auinger, P., & Ryan, S. (2006). Potentially protective factors associated with healthful body mass index in adolescents with obese and nonobese parents: a secondary data analysis of the third national health and nutrition examination survey, 1988-1994. *Journal of the American Dietetic Association, 106*(1), 55-64.

Freedman, D. S., Dietz, W. H., Srinivasan, S. R., & Berenson, G. S. (1999). The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study. *Pediatrics, 103*(6 Pt 1), 1175-1782.

Freedman, D. S., Khan, L. K., Serdula, M. K., Dietz, W. H., Srinivasan, S. R., & Berenson, G. S. (2005). The relation of childhood BMI to adult adiposity: the Bogalusa Heart Study. *Pediatrics, 115*(1), 22-27.

French, S. A. (2003). Pricing effects on food choices. *Journal of Nutrition, 133*(3), 841S-843S.

French, S. A., Story, M., Neumark-Sztainer, D., Fulkerson, J. A., & Hannan, P. (2001). Fast food restaurant use among adolescents: associations with nutrient intake, food choices and behavioral and psychosocial variables. *International Journal of Obesity and Related Metabolic Disorders, 25*(12), 1823-1833.

Garriguet, D. (2004). Overview of Canadians' eating habits [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/82-620-MIE2006002.pdf.

Gazzaniga, J. M., & Burns, T. L. (1993). Relationship between diet composition and body fatness, with adjustment for resting energy expenditure and physical activity, in preadolescent children. *American Journal of Clinical Nutrition, 58*, 21-28.

Gillis, L. J., Kennedy, L. C., Gillis, A. M., & Bar-Or, O. (2002). Relationship between juvenile obesity, dietary energy and fat intake and physical activity. *International Journal of Obesity, 26*, 458-463.

Goran, M. I., Ball, G. D. C., & Cruz, M. L. (2003). Obesity and risk of type 2 diabetes and cardiovascular disease in children and adolescents. *Journal of Clinical Endocrinology & Metabolism, 88*(4), 1417-1427.

Gordon-Larsen, P., Nelson, M. C., Page, P., & Popkin, B. M. (2006). Inequality in the built environment underlies key health disparities in physical activity and obesity. *Pediatrics, 117*(2), 417-424.

Gunnell, D. J., Frankel, S. J., Nanchahal, K., Peters, T. J., & Davey Smith, G. (1998). Childhood obesity and adult cardiovascular mortality: a 57-y follow-up study based on the Boyd Orr cohort. *American Journal of Clinical Nutrition, 67*(6), 1111-1118.

Guo, S. S., Wu, W., Chumlea, W. C., & Roche, A. F. (2002). Predicting overweight and obesity in adulthood from body mass index values in childhood and adolescence. *American Journal of Clinical Nutrition, 76*(3), 653-658.

Harris, S. B., Perkins, B. A., & Whalen-Brough, E. (1996). Non-insulin-dependent diabetes mellitus among First Nations children. New entity among First Nations people of north western Ontario. *Canadian Family Physician, 42*, 869-876.

Janssen, I., Boyce, W. F., Simpson, K., & Pickett, W. (2006). Influence of individual- and area-level measures of socioeconomic status on obesity, unhealthy eating, and physical inactivity in Canadian adolescents. *American Journal of Clinical Nutrition, 83*(1), 139-145.

Janssen, I., Katzmarzyk, P. T., Boyce, W. F., King, M. A., & Pickett, W. (2004). Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns. *Journal of Adolescent Health, 35*(5), 360-367.

Katzmarzyk, P. T., & Janssen, I. (2004). The economic costs associated with physical inactivity and obesity in Canada: an update. *Canadian Journal of Applied Physiology, 29*(1), 90-115.

Kirkpatrick, S. W., & Sanders, D. M. (1978). Body mage stereotypes: A developmental comparison. *Journal of Genetic Psychology, 132*(1), 87-95.

Kraig, K. A., & Keel, P. K. (2001). Weight-based stigmatization in children. *International Journal of Obesity and Related Metabolic Disorders, 25*(11), 1661-1666.

Larson, N. I., Story, M., Wall, M., & Neumark-Sztainer, D. (2006). Calcium and dairy intakes of adolescents are associated with their home environment, taste preferences, personal health beliefs, and meal patterns. *Journal of the American Dietetic Association, 106*(11), 1816-1824.

Latner, J. D., & Stunkard, A. J. (2003). Getting worse: the stigmatization of obese children. *Obesity Research, 11*(3), 452-456.

Lauer, R. M., Lee, J., & Clarke, W. R. (1988). Factors affecting the relationship between childhood and adult cholesterol levels: the Muscatine Study. *Pediatrics, 82*(3), 309-318.

Maffeis, C., Pinelli, L., & Schutz, Y. (1996). Fat intake and adiposity in 8 to 11-year-old obese children. *International Journal of Obesity and Related Metabolic Disorders, 20*(2), 170-174.

Minaker, L. M., McCargar, L., Lambraki, I., Jessup, L., Driezen, P., Calengor, K., & Hanning, R. M. (2006). School region socio-economic status and geographic locale is associated with food behaviour of Ontario and Alberta adolescents. *Canadian Journal of Public Health, 97*(5), 357-361.

Must, A., Jacques, P. F., Dallal, G. E., Bajema, C. J., & Dietz, W. H. (1992). Long-term morbidity and mortality of overweight adolescents. A follow-up of the Harvard Growth Study of 1922 to 1935. *New England Journal of Medicine, 327*(19), 1350-1355.

Must, A., & Strauss, R. S. (1999). Risks and consequences of childhood and adolescent obesity. *International Journal of Obesity and Related Metabolic Disorders, 23 Suppl 2*, S2-S11.

Neumark-Sztainer, D., French, S. A., Hannan, P. J., Story, M., & Fulkerson, J. A. (2005). School lunch and snacking patterns among high school students: associations with school food environment and policies. *International Journal of Behavioral Nutrition and Physical Activity, 2*(1), 14-20.

Neumark-Sztainer, D., Hannan, P. J., Story, M., Croll, J., & Perry, C. (2003). Family meal patterns: associations with sociodemographic characteristics and improved dietary intake among adolescents. *Journal of the American Dietetic Association, 103*(3), 317-322.

Neumark-Sztainer, D., Wall, M., Perry, C., & Story, M. (2003). Correlates of fruit and vegetable intake among adolescents. Findings from Project EAT. *Preventive Medicine, 37*(3), 198-208.

Nguyen, V. T., Larson, D. E., Johnson, R. K., & Goran, M. I. (1996). Fat intake and adiposity in children of lean and obese parents. *American Journal of Clinical Nutrition, 63*, 507-513.

Obarzanek, E., Schreiber, G. B., Crawford, P. B., Goldman, S. R., Barrier, P. M., Frederick, M. M., & Lakatos, E. (1994). Energy intake and physical activity in relation to indexes of body fat: the National Heart, Lung, and Blood Institute Growth and Health Study. *American Journal of Clinical Nutrition, 60*, 15-22.

Plotnikoff, R. C., Bercovitz, K., & Loucaides, C. A. (2004). Physical activity, smoking, and obesity among Canadian school youth. Comparison between urban and rural schools. *Canadian Journal of Public Health, 95*(6), 413-418.

Raine, K. D. (2004). Overweight and obesity in Canada: A population health perspective [Electronic Version]. *Canadian Population Health Initiative*, 1-81 from http://www.cihi.ca/cihiweb/dispPage.jsp?cw_page=GR_1130_E.

Reilly, J. J., Methven, E., McDowell, Z. C., Hacking, B., Alexander, D., Stewart, L., & Kelnar, C. J. (2003). Health consequences of obesity. *Archives of Disease in Childhood, 88*(9), 748-752.

Richardson, S. A., Hastorff, A. H., Goodman, N., & Dornbusch, S. M. (1961). Cultural uniformity in reaction to physical disabilities. *American Sociological Review, 26*, 241-247.

Ruvession, R., & Tataranni, P. A. (1997). Dietary fat and human obesity. *Journal of the American Dietetic Association, 97*, S42-S46.

Serdula, M. K., Ivery, D., Coates, R. J., Freedman, D. S., Williamson, D. F., & Byers, T. (1993). Do obese children become obese adults? A review of the literature. *Preventive Medicine, 22*(2), 167-177.

Shields, M. (2005). Measured obesity: Overweight Canadian children and adolescents [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/2005001/pdf/cobesity.pdf.

Srinivasan, S. R., Myers, L., & Berenson, G. S. (2006). Changes in metabolic syndrome variables since childhood in prehypertensive and hypertensive subjects: the Bogalusa Heart Study. *Hypertension, 48*(1), 33-39.

Striegel-Moore, R. H., Thompson, D., Affenito, S. G., Franko, D. L., Obarzanek, E., Barton, B. A., Schreiber, G. B., Daniels, S. R., Schmidt, M., & Crawford, P. B. (2006). Correlates of beverage intake in adolescent girls: the National Heart, Lung, and Blood Institute Growth and Health Study. *Journal of Pediatrics, 148*(2), 183-187.

Swinburn, B., Egger, G., & Raza, F. (1999). Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Preventive Medicine, 29*(6 Pt 1), 563-570.

Tjepkema, M. (2005). Measured obesity: Adult obesity in Canada [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/2005001/pdf/aobesity.pdf.

Tremblay, M. S., Inman, J. W., & Willms, J. D. (2000). The relationship between physical activity, self-esteem, and academic achievement in 12-year-old children. *Pediatric Exercise Science*, 312-323.

Tremblay, M. S., Katzmarzyk, P. T., & Willms, J. D. (2002). Temporal trends in overweight and obesity in Canada, 1981-1996. *International Journal of Obesity and Related Metabolic Disorders, 26*(4), 538-543.

Tremblay, M. S., & Willms, J. D. (2000). Secular trends in the body mass index of Canadian children. *Canadian Medical Association Journal, 163*(11), 1429-1433.

Troiano, R. P., Briefel, R. R., Carroll, M. D., & Bialostosky, K. (2000). Energy and fat intakes of children and adolescents in the United States: Data from the National Health and Nutrition Examination surveys. *American Journal of Clinical Nutrition, 72*(5 Suppl), 1343S-1353S.

Troiano, R. P., & Flegal, K. M. (1999). Overweight prevalence among youth in the United States: why so many different numbers? *International Journal of Obesity and Related Metabolic Disorders, 23 Suppl 2*, S22-S27.

Tucker, L. A., Seljaas, G. T., & Hager, R. L. (1997). Body fat percentage of children varies according to their diet composition. *Journal of the American Dietetic Association, 97*(9), 981-986.

Wang, Y. C., Gortmaker, S. L., Sobol, A. M., & Kuntz, K. M. (2006). Estimating the energy gap among US children: a counterfactual approach. *Pediatrics, 118*(6), 1721-1733.

Warschburger, P. (2005). The unhappy obese child. *International Journal of Obesity (Lond), 29 Suppl 2*, S127-S129.

Webber, L. S., Srinivasan, S. R., Wattigney, W. A., & Berenson, G. S. (1991). Tracking of serum lipids and lipoproteins from childhood to adulthood. The Bogalusa Heart Study. *American Journal of Epidemiology, 133*(9), 884-899.

Weiss, R., Taksali, S. E., & Caprio, S. (2006). Development of type 2 diabetes in children and adolescents. *Current Diabetes Reports, 6*(3), 182-187.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *The New England Journal of Medicine, 337*(13), 869-873.

World Health Organization. (2006). Obesity and overweight. *Fact sheets*, from http://www.who.int/mediacentre/factsheets/fs311/en/

World Health Organization. (2007). Obesity and overweight. *Chronic disease information sheets* Retrieved December 18, 2006, from http://www.who.int/dietphysicalactivity/publications/facts/obesity/en/

Young, T. K., Dean, H. J., Flett, B., & Wood-Steiman, P. (2000). Childhood obesity in a population at high risk for type 2 diabetes. *Journal of Pediatrics, 136*(3), 365-369.

Chapter 4: Determinants of diet quality among Canadian adolescents as assessed by a web-based survey

4.1 Preface

The following chapter is based on data from a self-administered web-based survey that was a collaborative project between the University of Alberta and the University of Waterloo. Grade 9 and 10 students (n = 2850) from both provinces participated. Data were examined to specifically investigate diet quality of the students. Data were collected between November 2002 and June 2003 using the *Food Behaviour Questionnaire* developed at the University of Waterloo.

This study was the first study using the web-based methodology in a province-wide sample and was conducted in order to determine the feasibility of using the web-based survey methodology in large samples. The provinces of Alberta and Ontario participated in the research study due to interests of researchers at both the University of Alberta and the University of Waterloo. Comparisons between Alberta and Ontario were not performed as the study was not designed for comparisons due to differences in sample size and seasonal variations during data collection.

4.2 Introduction

Overweight and obesity prevalence have increased dramatically over the past few decades among Canadian adolescents (Shields, 2005). The health impact of obesity is significant; adiposity has been linked to numerous health consequences (Ball & McCargar, 2003; Goran, Ball, & Cruz, 2003; Must & Strauss, 1999), and has been shown to track into adulthood (Freedman et al., 2005; Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Guo, Wu, Chumlea, & Roche, 2002; Serdula et al., 1993; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Due to the significant health (Dietz, 1998) and economic implications of adolescent obesity, research in the area of obesity determinants has become increasingly important. Specifically, individual behaviours such as poor nutritional intakes, physical inactivity, and sedentary activity have been identified as key issues in the development of obesity (Shields, 2005).

Data from the 2004 Canadian Community Health Survey (CCHS) indicated that Canadian adolescents are not meeting recommendations established by Canada's Food Guide to Healthy Eating (CFGHE), while concurrently consuming high intakes of Other Foods (Garriguet, 2004). Furthermore, adolescents often report high frequencies of breakfast skipping and consuming meals away from home (Garriguet, 2004), behaviours known to be associated with unfavorable nutritional intakes (Fiore, Travis, Whalen, Auinger, & Ryan, 2006; French, Story, Neumark-Sztainer, Fulkerson, & Hannan, 2001; Larson, Story, Wall, & Neumark-Sztainer, 2006; Rampersaud, Pereira, Girard, Adams, & Metzl, 2005). Although low intakes of CFGHE foods have been consistently observed in the adolescent Canadian population, less is known regarding the relationship between total diet quality and nutrition (nutrient intakes and sub-optimal meal behaviours). It is hypothesized that students are compensating for low intakes of foods found in CFGHE by consuming higher intakes of Other Foods (Garriguet, 2004). Further, it is believed that students with higher frequencies of breakfast skipping and consuming foods away from home will be meeting fewer recommendations as established by CFGHE. Therefore the purpose of this study was to investigate the current dietary intakes of a sample of Alberta and Ontario high school students and to identify whether students with poor diet quality had different macronutrient intakes, increased consumption of Other Foods and increased frequency of sub-optimal meal behaviours including breakfast skipping and consuming meals away from home compared to those with average or superior diet quality.

4.3 Methods

4.3.1 Participants

Schools containing grades nine and/or ten (students 14 to 17 years) in the provinces of Alberta and Ontario, Canada were selected based on a two-stage sampling technique. School boards (public and catholic) were selected based on regional classifications as defined by Alberta Education (Alberta Education, 2007a) and the Ontario Ministry of Education (Ontario Ministry of Education, 2003b) in order to obtain regional diversity within the sample. Four schools within each selected school board were randomly selected. In addition, private schools were randomly selected based on regional diversity. School boards and schools were initially contacted by mail (detailed information package) (**Appendix A1, A2, A3, A4, A5**) and follow-up phone contact was made to request permission to survey students in each school.

This research was approved by the University of Alberta Human Research Ethics Board in the Faculty of Agriculture, Forestry, and Home Economics (**Appendix B**), the Cooperative Activities Program in the Faculty of Education at the University of Alberta, the University of Waterloo Office of Research Ethics, and from each participating school board and school. Parents and students received information letters (**Appendix A6, A7**), and parental consent was obtained using either active or passive consent depending on school preference. All Alberta parents provided active consent (**Appendix A8**). Students also provided assent after logging on to the web-based survey (**Appendix A9**). The anonymous survey took approximately 30 – 40 minutes and was completed during the school day. Survey data were collected between November 2002 and June 2003, and thus nutritional intakes may have been affected by seasonal variation.

4.3.2 Procedures

4.3.2.1 Dietary Intake

Dietary intake was measured using a 24-hour dietary recall administered to students using the web-based *Food Behaviour Questionnaire* (Hanning, Jessup, Lambraki, MacDonald, & McCargar, 2003). Students reported all foods and beverages consumed during the previous day by selecting items from a list of approximately 500 foods. In addition, a portion of the sample (n = 150; total n = 2850) completed repeat 24-hour dietary recalls which were used in the micronutrient and fibre analyses in order to assess usual intake with the Software for Intake Distribution Estimation (PC-SIDE) developed by Nusser et al. (1996). To help students recall their intake, portion size images and cues regarding beverage intake were provided. In comparison to a dietitian-administered 24-hour dietary recall, the *Food Behaviour Questionnaire* showed good agreement (intraclass correlation coefficients (ICC)) for total caloric intake and macronutrients (ICC = 0.51 – 0.68), and key micronutrients (ICC = 0.47 to 0.78) when assessed over the same 24-hour period in grade 6 to 8 students (n = 51) (Hanning & Health Behaviour Research Group, 2004). In comparison to direct observation of food items selected at lunch hour versus those selected on the web-survey, grade 9 and 10 students (n = 15) showed an overall agreement of 87% (Hanning et al., 2004).

Diet quality was assessed using a food-based diet quality index (Lowik, Hulshof, & Brussaard, 1999), as recommended by Patricia et al. (2007) and modified to reflect CFGHE (Health Canada, 1992) foods. Individuals consume food groups, and not individual nutrients, therefore food-based diet quality indices provide information that can easily be used for health promotion purposes. Further, food based diet quality indices have been validated using the Mean Adequacy Ratio (MAR), a measure of nutrient adequacy (Shatenstein, Nadon, & Ferland, 2003). In the current study, servings of each of the four food groups including Grain Products, Vegetables and Fruit, Milk Products and Meat and Alternatives were calculated using data from the 24-hour dietary recall. Foods that were not classified according to CFGHE were categorized as Other Foods and further divided into sub-categories including mostly sugar (e.g., candies), high salt/fat (e.g., potato chips), high calorie beverages (e.g., regular soft drinks), low calorie beverages (e.g., low calorie soft drinks), or high sugar/fat (e.g., pastries). Individuals were classified as having poor, average, or superior diet quality according to the number of food group recommendations that were met based on CFGHE (poor = 0-1 food groups; average = 2-3 food groups; superior = all 4 food groups). This approach has not yet been validated. Although CFGHE was recently revised and replaced with Eating Well with Canada's Food Guide (Health Canada, 2007), the 1992 CFGHE was the government recommendation during data collection and was also a component of the Alberta (Alberta Learning, 2002, 2005) and Ontario (Ontario Ministry of Education, 2000, 2005) school curricula. Therefore, it was most appropriate to compare intakes to the 1992 CFGHE recommendations.

Nutrient analysis was completed using ESHA Food Processor version 7.9 (ESHA Research, 1987 - 2002) and the 2001b Canadian Nutrient File (Health Canada, 2001) database and compared to the Dietary Reference Intakes (DRIs) (Institute of Medicine, 1997, 1998, 2000a, 2000b, 2005). Carbohydrate, protein and fat were assessed using the Acceptable Macronutrient Distribution Ranges (AMDRs), while micronutrients and fibre were compared to either the Estimated Average Requirement (EAR) or the Adequate Intake (AI) (Institute of Medicine, 2000c). Prevalence of inadequacy was determined for those nutrients with an EAR. Prevalence of inadequacy cannot be determined for nutrients with an AI, as many values below the AI are likely to be adequate (Institute of Medicine, 2000c). Dietary Reference Intakes and CFGHE requirements are presented in **Tables 4.1 and 4.2.**

4.3.2.2 Sub-Optimal Meal Behaviours

Survey questions examining sub-optimal meal behaviours are comparable to questions developed for Project EAT (Eating Among Teens), a well-established survey instrument (Neumark-Sztainer, Story, Hannan, Perry, & Irving, 2002; Neumark-Sztainer, Wall, Story, & Perry, 2003). Frequency of meal consumption was assessed by asking students "How often do you usually eat?" followed by "breakfast", "lunch", "dinner", "morning snacks", afternoon snacks", and "evening snacks". Response options included "Never", "On weekends only", "Less than half of the week (≤ 3 days/week)", "More than half of the week (≥ 4 days/week)", "Every day", and "Not answered". Each response was assigned a score between 1 and 5 ("never" = 1, "every day" = 5), with higher scores representing a greater frequency of consuming each meal. Frequency of consuming meals away from home was assessed by asking "How often do you eat meals or snacks prepared away from home?", with response options of "rarely or never", "once a month", "once a week", "2-6 times a week", and "once a day". Each response was assigned a score between 1 and 5 ("rarely or never" = 1, "once a day" = 5), with higher scores representing a greater frequency of consuming meals away from home. The following locations were assessed: school cafeteria, fast food restaurant or take out, other restaurants, vending machines, snack bars (e.g., the canteen at an arena), and convenience stores.

4.3.2.3 Statistical Analyses

It is known that micronutrient inadequacy cannot be determined using a one-day measure due to non-normal distributions in nutrient intakes. Food intake varies between individuals as well as within individuals, thus it is essential to separate inter-individual from intra-individual variation. In order to do this, however, multiple days of intake data are required (Barr, 2006). The PC-SIDE software (Nusser et al., 1996) was used to adjust for intra-individual variation producing estimates of usual intake and prevalence of micronutrient inadequacy as expressed as the percent below the EAR.

Descriptive statistics, chi-squared tests, t-tests, and Mann-Whitney U tests were performed to analyze macronutrient intakes, food group intakes and intake differences between genders. A 2 x 3 multivariate analysis of co-variance (MANCOVA) was used to evaluate the association between gender (boys, girls) and diet quality (poor, average, superior), where total caloric intake (energy) was the covariate as recommended by Willet (1998). Univariate follow-ups on significant MANCOVA results were completed on the dependent variables which included nutrient intakes, servings of Other Foods, frequency of meal consumption, and frequency of consuming meals away from home. The mean of reported frequencies for morning, afternoon, and evening snacks was used to assess overall frequency of snack consumption. Prior to the MANCOVA analyses, the assumption of homogenous slopes (D'Alonzo, 2004; Tabachnick & Fidell, 2007) was tested, and interactions indicated that the slopes differed among levels of the independent variables. Therefore, adjusted values were based on custom models which included these interactions for the following MANCOVA analyses: macronutrients, Other Foods, and frequency of meal consumption. Statistical significance was accepted at $p < 0.05$, and all analyses were performed by using the software program SPSS (version 15.0; SPSS Inc, Chicago).

4.4 Results

4.4.1 Demographics

There were 2930 adolescents who participated in the study. Students were excluded from the dataset if they logged on but did not complete the survey (n = 31), did not complete the 24-hour recall (n = 35), and/or had extreme values of total caloric intake based on outlier analyses (n = 14) resulting in a final sample of 2850 students. During data collection, students were free to end the survey at any time, and were not required to answer every question in order to participate. Therefore, sample size varies throughout the analyses. Thus, the final sample of 2850 adolescents used for analyses included the following: boys = 1233; girls = 1596; Alberta = 762; Ontario = 2088; average age = 14.8 years. In total, 160 schools were contacted of which 70 (44%) agreed to participate. Upon completion of the study, a total of 57 (36%) schools (31 Alberta, 26 Ontario) within 28 school boards (17 Alberta, 11 Ontario) actually participated. Based on total Alberta (Alberta Education, 2007b) and Ontario (Ontario Ministry of Education, 2003a) student enrolment, representation from the two provinces was approximately equal proportion. Although schools were selected for participation randomly, the resulting sample represents a convenience sample of Alberta and Ontario students. For schools that did not participate, the main reason for refusal was due to time constraints throughout the school year.

4.4.2 Nutrient Intakes

The mean energy intakes for boys and girls were 2636 kilocalories (kcals)/day and 1830 kcals/day respectively. On average, boys and girls met the AMDR recommendations for macronutrients with 53.8%, 15.3% and 32.3% of total energy intake from carbohydrate, protein and fat respectively for boys; while girls' intake distribution was 56.0% from carbohydrate, 14.6% from protein, and 31.1% from fat. Boys consumed significantly more total energy (kcals/day) than girls (boys = 2636 ± 1282 kcals/day; girls = 1830 ± 905 kcals/day) ($t = 18.76$, $p < 0.001$). In addition, boys consumed more protein (as a percent of energy: % kcal) ($t = 3.5$, $p < 0.001$) and fat (% kcal) ($t = 3.4$, $p = 0.001$), and less carbohydrate (% kcal) ($t = -5.4$, $p < 0.001$) than girls.

The adjusted average micronutrient and fibre intakes, in addition to the prevalence of inadequacy by gender are presented in **Table 4.1**. These nutrients are considered to be key micronutrients for optimal nutritional intakes and are generally found in high amounts in foods represented in the four food groups.

Table 4.1: Dietary Reference Intakes (DRIs) (Institute of Medicine, 1997, 1998, 2000a, 2000b, 2005) and Adjusted Average Intakes Compared to Recommendations Among Adolescents Aged 14 to 17 Years

Nutrient	DRI Value (DRI Category)[*]	Adjusted Average Intake[†]	Percent below the EAR[‡]
Vitamin A (µg)[§]			
Boys	630 (EAR)	36.0	
Girls	485 (EAR)	34.3	
Vitamin C (mg)			
Boys	63 (EAR)	159.6	17.3
Girls	56 (EAR)	137.0	14.3
Iron (mg)			
Boys	7.7 (EAR)	16.5	7.8
Girls	7.9 (EAR)	10.5	32.0
Niacin (mg)			
Boys	12 (EAR)	21.9	10.6
Girls	11 (EAR)	14.5	28.2
Zinc (mg)			
Boys	8.5 (EAR)	12.2	28.2
Girls	7.3 (EAR)	7.8	51.9
Calcium (mg)			
Boys	1,300 (AI)	1245.0	
Girls	1,300 (AI)	920.2	
Vitamin D (µg)			
Boys	5 (AI)	6.2	
Girls	5 (AI)	4.5	
Fibre (g)			
Boys	38 (AI)	16.1	
Girls	26 (AI)	13.0	

[*] EAR = Estimated Average Requirement, AI = Adequate Intake

[†] Adjusted for intra-individual variation of intake using the Software for Intake Distribution Estimation (PC-SIDE)

[‡] Calculated only for nutrients with an EAR as recommended by the Institute of Medicine (Institute of Medicine, 2000c).

[§] An estimate of inadequacy (percent below the EAR) could not be determined for vitamin A due to high frequencies of individual intakes at 0 µg.

Abbreviations: µg (micrograms), mg (milligrams), g (grams)

Median food group intakes and interquartile ranges are presented in **Table 4.2.** Boys consumed significantly higher intakes of all food groups (**Table 4.2**). In addition, boys were more likely than girls to meet CFGHE recommendations for Grain Products

(χ^2 (1) = 127.84; $p < 0.001$), Vegetables and Fruit (χ^2 (1) = 23.15; $p < 0.001$), Meat and Alternatives (χ^2 (1) = 130.88; $p < 0.001$), and Milk Products (χ^2 (1) = 55.38; $p < 0.001$) (n = 2829). Among boys, 56% met the CFGHE recommendation for Grain Products, 50% for Vegetables and Fruit, 68% for Meat and Alternatives and 45% for Milk Products. In comparison, only 35% of girls met the CFGHE recommendation for Grain Products, 41% for Vegetables and Fruit, 47% for Meat and Alternatives, and 32% for Milk Products.

Table 4.2: Canada's Food Guide to Healthy Eating Recommendations (Health Canada, 1992) and 25th, 50th and 75th Percentiles of Servings Consumed by Canadian Adolescents Aged 13 to 17 Years*

CFGHE Groups (Recommended Daily Servings)	Number of Servings						P Value†
	Boys (n = 1233)			Girls (n = 1596)			
	25th	50th	75th	25th	50th	75th	
Grain Products (5 – 12)	3.2	5.7	8.9	2.3	3.9	6.0	< 0.001
Vegetables and Fruit (5 – 10)	2.5	5.0	8.0	2.3	4.2	6.8	< 0.001
Milk Products (10 to 16 years: 3 – 4)	1.1	2.5	4.3	0.8	1.8	3.3	< 0.001
Meat and Alternatives (2 – 3)	1.5	3.2	5.2	0.8	1.6	3.0	< 0.001
Other Foods (in moderation)	3.1	6.0	9.0	2.5	4.6	7.2	< 0.001

*Four students were younger than age 13 due to mixed grade level classrooms
†Significance between genders using Mann-Whitney U test

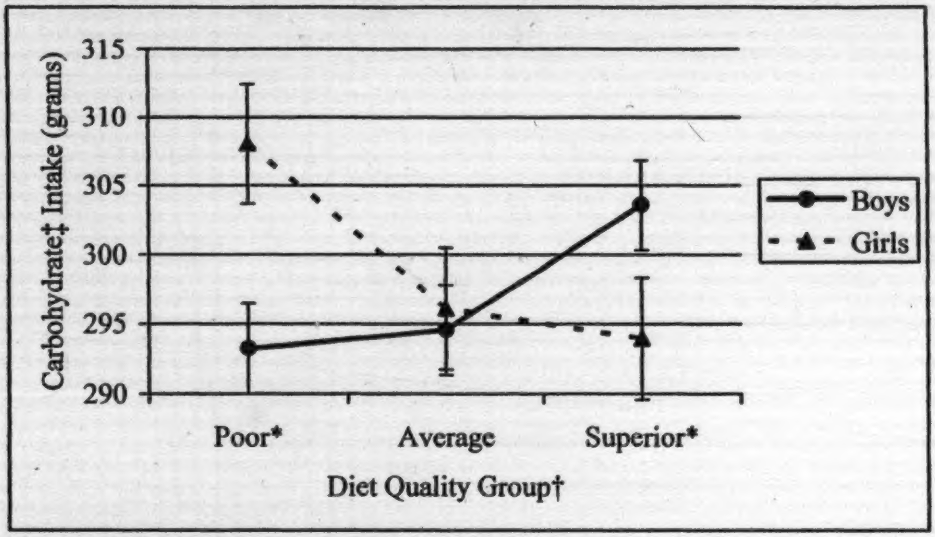
4.4.3 Diet Quality

Overall diet quality indicated that 43% (n = 1206) of students had poor diet quality, 47% (n = 1331) had average diet quality and 10% (n = 292) had superior diet quality. Among boys, 30% (n = 365) had poor diet quality, 54% (n = 668) had average diet quality and 16% (n = 200) had superior diet quality. In comparison, 53% (n = 841) of girls had poor diet quality, 42% (n = 663) had average diet quality and 6% (n = 92) had superior diet quality.

4.4.3.1 Diet Quality and Nutrient Intakes

The MANCOVA used to assess macronutrient intakes indicated that significant multivariate interactions existed between diet quality and gender (Wilks' Lambda = 0.99, F(8, 5632) = 2.06, p = 0.036), and main effects for diet quality (Wilks' Lambda = 0.97, F(8, 5632) = 10.27, p < 0.001) and gender (Wilks' Lambda = 1.00, F(4, 2816) = 3.00, p = 0.018). Interactions indicated that boys in the superior diet quality group consumed more carbohydrates than girls in the same group, whereas girls in the poor diet quality group consumed more carbohydrates than boys in the same group (**Figure 4.1**). Further, girls in the superior diet quality group consumed more fat than boys in the same group (**Figure 4.2**). Follow-up univariate analyses for gender revealed significance for protein (F(1, 2819) = 18.07, p < 0.001), fat (F(1, 2819) = 4.03, p = 0.045) and fibre (F(1, 2819) = 23.06, p < 0.001) where boys consumed more protein, and less fat and fibre than girls. As presented in **Table 4.3**, the univariate analyses revealed that those with poor diet quality had significantly lower intakes of protein and fibre, and significantly higher intakes of fat compared to both those with average diet quality as well as those with superior diet quality. Further, those with average diet quality had significantly lower intakes of protein and fibre and significantly higher intakes of fat compared to those with superior diet quality. No differences were seen in carbohydrate intakes between groups.

Figure 4.1: Interaction between Diet Quality and Gender: Carbohydrate Intake

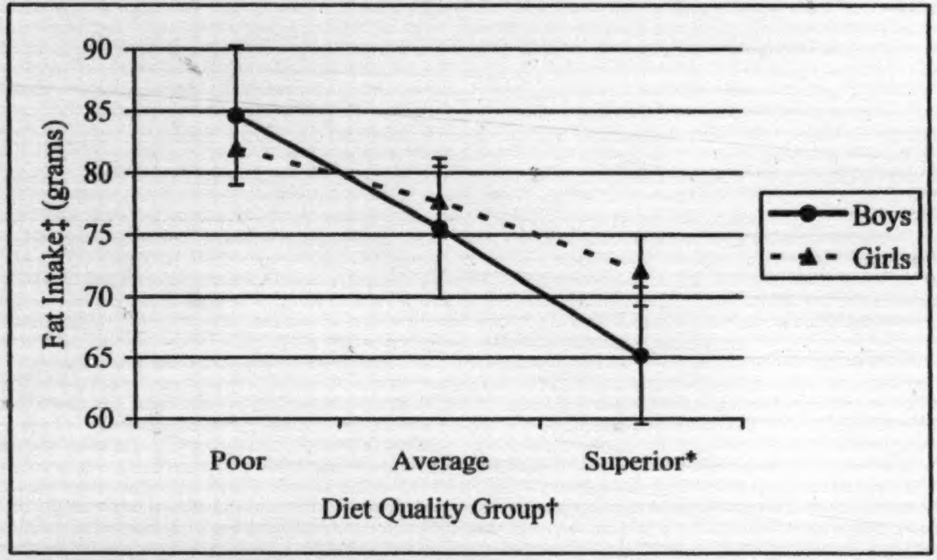


*Significant interaction at $p < 0.05$

†Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations

‡Adjusted for total caloric intake (energy)

Figure 4.2: Interaction between Diet Quality and Gender: Fat Intake



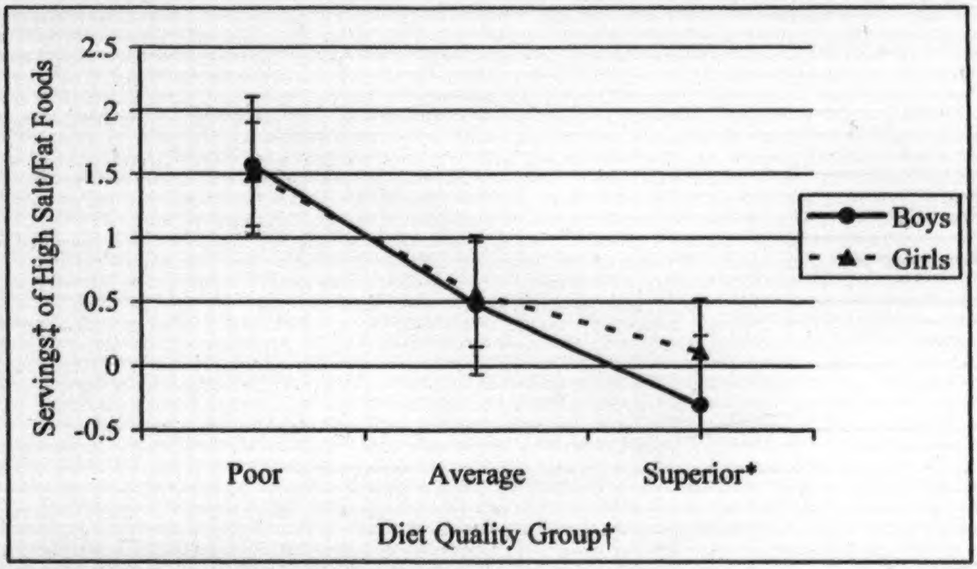
*Significant interaction at $p < 0.05$

†Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations

‡Adjusted for total caloric intake (energy)

Significant multivariate interactions for Other Foods sub-categories existed between diet quality and gender (Wilks' Lambda = 0.99, F(10, 5630) = 1.85, p = 0.047) as well as the main effects for diet quality (Wilks' Lambda = 0.98, F(10, 5630) = 5.76, p < 0.001) and gender (Wilks' Lambda = 0.99, F(5, 2815) = 3.23, p = 0.007). Interactions indicated that boys in the superior diet quality group consumed less high salt/fat foods than girls in the same group (**Figure 4.3**). Univariate follow-up analyses for gender revealed that boys consumed less foods containing mostly sugar (F(1, 2819) = 9.94, p = 0.002), high salt/fat foods (F(1, 2819) = 4.21, p = 0.040), and low calorie beverages (F(1, 2819) = 12.99, p < 0.001); and more high calorie beverages (F(1, 2819) = 16.35, p < 0.001) than girls. **Table 4.3** provides data on differences in intakes of Other Food sub-categories between those with poor, average and superior diet quality. The univariate analyses revealed that those with poor diet quality had significantly higher intakes of all Other Foods sub-categories, with the exception of low calorie beverages which was significantly lower compared to those with superior diet quality. Differences between poor and average diet quality groups (high salt/fat foods, high calorie beverages, high sugar/fat foods) and between average and superior diet quality groups (high salt/fat foods, high calorie beverages, high sugar/fat foods, low calorie beverages) also existed, and are presented in **Table 4.3**.

Figure 4.3: Interaction between Diet Quality and Gender: High Salt/Fat Food Intake



*Significant interaction at $p < 0.05$

†Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations

‡Adjusted for total caloric intake (energy)

Table 4.3: Group Difference in Adjusted[*] Nutrient Intakes Based on Diet Quality[†]

	Diet Quality[‡]			F Value	P Value
	Poor	Average	Superior		
Nutrients (g) (n = 2829)					
Carbohydrate	300.66 ± 2.36[§]	295.36 ± 1.54	298.78 ± 5.07	1.81	nsd
Protein	65.38 ± 1.09^{a}	85.28 ± 0.71^{b}	100.11 ± 2.34^{c}	153.91	< 0.001$^{ab, ac, bc}$
Fat	83.31 ± 0.90^{a}	76.64 ± 0.59^{b}	68.66 ± 1.94^{c}	31.62	< 0.001$^{ab, ac, bc}$
Fibre	13.56 ± 0.32^{a}	14.85 ± 0.21^{b}	16.98 ± 0.69^{c}	11.87	0.001^{ab}; < 0.001^{ac}; 0.003^{bc}
Other Food Groups Sub-categories (servings/day) (n = 2829)					
Mostly Sugar	0.62 ± 0.04^{a}	0.53 ± 0.03	0.39 ± 0.09^{c}	3.07	0.022^{ac}
High Salt/Fat	1.51 ± 0.05^{a}	0.52 ± 0.03^{b}	-0.10 ± 0.11^{c}	154.70	< 0.001 $^{ab, ac, bc}$
High Calorie Beverages	1.67 ± 0.06^{a}	0.85 ± 0.04^{b}	0.42 ± 0.13^{c}	79.29	< 0.001$^{ab, ac}$; 0.001^{bc}
Low Calorie Beverages	1.18 ± 0.09^{a}	1.25 ± 0.06^{a,b}	1.70 ± 0.19^{c}	3.30	0.011^{ac}; 0.020^{bc}
High Sugar/Fat	0.58 ± 0.04^{a}	0.42 ± 0.02^{b}	0.17 ± 0.08^{c}	13.13	< 0.001$^{ab, ac}$; 0.002^{bc}

[*] Adjusted for total caloric intake (energy)

[†] Univariate analyses

[‡] Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations

[§] Mean ± SE (the two decimal places represent statistical requirements, however the accuracy of the instrument is appropriate to the level of whole numbers only)

^{a,b,c}Different superscript letters in each row indicate significant statistical differences

Abbreviations: g (grams), SE (standard error of the mean), nsd (no significant difference)

4.4.3.2 Diet Quality and Sub-Optimal Meal Behaviours

The association between diet quality and gender with meal frequency as assessed using a MANCOVA revealed significant F values for diet quality (Wilks' Lambda = 0.96, F(8, 4050) = 9.80, $p < 0.001$), but not for gender (Wilks' Lambda = 1.00, F(4, 2025) = 2.25, $p = 0.061$) or for an interaction between diet quality and gender (Wilks' Lambda = 1.00, F(8, 4050) = 0.30, $p = 0.967$). Univariate analyses revealed that those with poor diet quality had a lower frequency of breakfast and lunch consumption compared to those with average diet quality. Those with poor diet quality also had a lower frequency of breakfast consumption compared to those with superior diet quality. No differences were observed for dinner or snack consumption (**Table 4.4**).

Frequency of consuming meals away from home yielded significant main effects for diet quality (Wilks' Lambda = 0.97, F(12, 4810) = 5.63, $p < 0.001$) and gender (Wilks' Lambda = 0.99, F(6, 2405) = 5.52, $p < 0.001$), but not for the interaction between diet quality and gender (Wilks' Lambda = 0.99, F(12, 4810) = 1.25, $p = 0.242$). Follow-up univariate analyses for gender revealed that compared to girls, boys consumed more meals or snacks at all locations: fast food or take-out (F(1, 2410) = 24.87, $p < 0.001$), other restaurants (F(1, 2410) = 6.87, $p = 0.009$), vending machines (F(1, 2410) = 10.29, $p = 0.001$), snack bars (F(1, 2410) = 5.84, $p = 0.016$) and convenience stores (F(1, 2410) = 17.35, $p < 0.001$). Results of the univariate analyses comparing those with poor, average and superior diet quality in terms of frequency of consuming meals away from home are presented in **Table 4.4**. Those with poor diet quality consumed significantly more meals or snacks away from home at all locations compared to those with superior diet quality. Significant differences were also observed between those with poor and average diet

quality and between those with average and superior diet quality, and are presented in Table 4.4.

Table 4.4: Group Differences in Sub-Optimal Meal Behaviours[*] Based on Diet Quality[†]

	Diet Quality[‡]			F Value	P Value
	Poor	Average	Superior		
Meal Frequency[§] (n = 2038)					
Breakfast	$3.89 \pm 0.06^{**,a}$	4.13 ± 0.05^{b}	$4.38 \pm 0.17^{b,c}$	6.85	0.002^{ab}; 0.006^{ac}
Lunch	4.46 ± 0.05^{a}	4.59 ± 0.03^{b}	4.68 ± 0.12	3.41	0.017^{ab}
Dinner	4.83 ± 0.03	4.87 ± 0.02	4.87 ± 0.08	0.70	nsd
Snacks	3.41 ± 0.05	3.42 ± 0.04	3.29 ± 0.13	0.44	nsd
Consuming Meals and Snacks Away From Home[††] (n = 2417)					
School Cafeteria	2.78 ± 0.06^{a}	$2.68 \pm 0.05^{a,b}$	2.33 ± 0.12^{c}	5.27	0.001^{ac}; 0.004^{bc}
Fast Food/Take Out	2.70 ± 0.04^{a}	2.48 ± 0.03^{b}	2.18 ± 0.07^{c}	18.41	$< 0.001^{ab,\, ac,\, bc}$
Other Restaurants	2.16 ± 0.03^{a}	2.04 ± 0.03^{b}	$1.96 \pm 0.07^{b,c}$	4.12	0.011^{ab}; 0.014^{ac}
Vending Machines	2.79 ± 0.05^{a}	2.44 ± 0.04^{b}	2.22 ± 0.10^{c}	17.57	$< 0.001^{ab,\, ac}$; 0.026^{bc}
Snack Bars	2.21 ± 0.04^{a}	1.98 ± 0.03^{b}	$1.82 \pm 0.09^{b,c}$	9.25	$< 0.001^{ab,\, ac}$
Convenience Stores	2.76 ± 0.04^{a}	2.45 ± 0.03^{b}	$2.32 \pm 0.09^{b,c}$	15.83	$< 0.001^{ab,\, ac}$

[*] Adjusted for total caloric intake (energy)

[†] Univariate analyses

[‡] Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations

[§] Meal Frequency: never = 1, on weekends only = 2, less than half of the week (three or fewer days each week) = 3, more than half of the week (four or more days each week) = 4, every day = 5; Snacks were averaged before analysis (morning snacks, afternoon snacks, evening snacks)

[**] Mean ± SE

[††] Consuming Meals and Snacks Away From Home: rarely or never = 1, once a month = 2, once a week = 3, 2-6 times a week = 4, once a day = 5

[a,b,c] Different superscript letters in each row indicate significant statistical differences

Abbreviations: SE (standard error of the mean), nsd (no significant difference)

4.5 Discussion

In this study, we examined the nutritional intakes of Alberta and Ontario adolescents, and compared a measure of diet quality to intakes and sub-optimal meal behaviours. The main results of this study demonstrate that while most adolescents are meeting the AMDR recommendations, many adolescents are not meeting minimum DRI and CFGHE recommendations, and thus have poor diet quality. Further, adolescents with lower diet quality had significantly different intakes of macronutrients and greater frequencies of sub-optimal meal behaviours.

4.5.1 Nutrient Intakes

Consistent with previous reports (Garriguet, 2004), boys' and girls' intakes were within the AMDRs; however, these recommendations are ranges of the distribution of the diet and not absolute values. Further, both boys and girls were at the upper end of the range for fat consumption with 32.3% (boys) and 31.1% (girls) of total energy coming from fat. Although the effect of dietary fat intake on weight status is inconclusive, the association between dietary fat intake and chronic disease is of concern. Autopsy studies have shown that the early signs of atherosclerosis exist in adolescents, and researchers have even identified fatty streaks in the aorta of children as young as three years of age. This suggests that atherosclerosis begins in childhood, making the dietary choice of adolescents extremely important (Burke, 2006).

Based on nutrient analysis, adolescents met the requirements for most nutrients, however the intakes of iron, zinc, and calcium (AI) for girls, in addition to the intakes of fibre (AI) for both boys and girls were of concern. Although vitamin A intake appeared to be low, this was likely due to the wide variation in daily intake of this nutrient (Institute of Medicine, 2000c). In this sample of adolescents, we found that 32% of girls fell below the EAR for iron, and therefore were at risk of inadequacy. Although the EAR for iron was established to replace losses, there is considerable variation in the losses that occur during menstruation. The resulting effect is that the percent below the EAR determined using the EAR cut-point method likely underestimated the true prevalence of inadequacy (Institute of Medicine, 2000c). Zinc intakes in girls were also low, which is uncommon in North America due to the abundance of zinc found in animal products (Institute of Medicine, 2000a). It is likely that the observed low intakes of zinc in this study were due to low intakes of foods found in the Meats and Alternatives and Milk Products categories of CFGHE. The AI for calcium was established to promote optimal levels of calcium retention, which in turn is important for growth and the prevention of osteoporosis (Institute of Medicine, 1997). The AI for total fibre in adolescents was established to reduce the risk of coronary heart disease, diet-related cancer, obesity and type 2 diabetes (Institute of Medicine, 2005). Although adequacy of the group's intake for nutrients with an AI cannot be determined, it is apparent that many adolescents in this sample do not have optimal nutrition for prevention of disease in terms of both calcium and fibre.

Although the adjusted mean intakes of nutrients were consistent with results from previous studies (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Veugelers, Fitzgerald, & Johnston, 2005), the percent of inadequacy of individual nutrients was higher in the present study than was found in the Children's Lifestyle And School-performance Study (CLASS). However, this is due to the difference in requirements between younger (9 to 13 years) and older (14 to 18 years) students. With the exception of calcium, recommended DRIs are higher in those aged 14 to 18 years. The observed similarity in adjusted mean intakes suggests that older adolescents have similar intakes to their younger peers, at a time when physiologically their requirements have increased due to increased growth and development. Although children and adolescents are often categorized as one group, these results demonstrate the importance of assessing children and adolescents separately.

Consistent with previous national statistics (Garriguet, 2004) and concurrent with observed micronutrient intakes, intakes of foods found in CFGHE were low. Further, median intakes of Other Foods were higher than any other CFGHE food group for both boys and girls. It is likely that both boys and girls were compensating for high intakes of Other Foods by decreasing consumption of foods found in CFGHE which also corresponds to sub-optimal micronutrient intakes.

4.5.2 Diet Quality

Although the importance of individual food groups has been well established, less is known about the significance and determinants of total diet quality in the adolescent population. Intake of Fruits and Vegetables has been shown to be protective for obesity (Shields, 2005), while Milk Products are important for bone health (Institute of Medicine, 1997). Meat and Alternatives are key sources of iron, which is important for growth and development, and the prevention of anemia (Institute of Medicine, 2000a). Grain Products provide the greatest proportion of total energy to the diet, and are also important sources of fibre, a nutrient known to be associated with prevention of disease (Institute of

Medicine, 2005). Although each food group is individually important, total health and wellness relies on the appropriate balance of all four food groups. Overall diet quality in this study was sub-optimal with 43%, 47% and 10% of students having poor, average and superior diet quality respectively. Therefore, many adolescents may have intakes that put them at risk for various health consequences associated with inadequate consumption of CFGHE foods.

4.5.2.1 Diet Quality and Nutrient Intakes

Results from this study indicated that those with poor diet quality had lower intakes of protein, fibre and low calorie beverages and higher intakes of fat and Other Foods sub-categories compared to those with average or superior diet quality. Further, this difference was observed between those with average and superior diet quality, which suggests a stepwise positive difference in intakes between groups (from poor to average to superior) and supports the importance of meeting all four CFGHE food groups. These results suggest that students who consumed fewer servings of Other Foods were more likely to adhere to CFGHE (due to their higher diet quality score), resulting in a healthier diet containing higher amounts of protein and fibre, and lower amounts of fat. A study by Larson et al. (2006) indicated that reduced milk consumption was associated with high intakes of soft drinks. Although the current study did not examine the relationship between soft drinks and milk consumption, those with poor diet quality did consume greater amounts of high calorie beverages. In the current research, the mean value for fibre in those with superior diet quality was well below the DRI recommendation. However, this value was significantly higher than was observed in those with poor and average diet quality. In addition, although a decrease in fat intake over time has been observed in the Canadian adolescent population (Garriguet, 2004), these results indicate that many adolescents may still be at risk for the negative health consequences associated with high fat intakes such as cardiovascular disease. However, it should be noted that mean differences in nutrient intakes between diet quality groups were small, indicating that although trends were observed, the biological relevance in consuming small, yet significant differences in macronutrients is unclear.

4.5.2.2 Diet Quality and Sub-Optimal Meal Behaviours

The association between sub-optimal meal behaviours and CFGHE is not well understood. Breakfast skipping has been shown to be associated with obesity in American adolescents (Albertson, Anderson, Crockett, & Goebel, 2003; Fiore et al., 2006; Rampersaud et al., 2005), while fast food consumption has been associated with higher intakes of total energy, percent energy from fat, daily servings of soft drinks, and lower intakes of fruit, vegetables and milk (French et al., 2001). In the current study, adolescents with poor diet quality had a lower frequency of breakfast consumption compared to those with average and superior diet quality, indicating that regular breakfast consumption may be an important determinant of whether or not a student was able to meet the minimum recommendations for CFGHE. This is consistent with previous research which indicated that breakfast consumption was associated with higher Healthy Eating Index Scores (a measure of diet quality) (Basiotis, Lino, & Anand, 1999). Students with poor diet quality also consumed lunch less frequently than those with average diet quality, further demonstrating the importance of consuming regular meals.

Although consuming regular meals is important, the location of the meal may be equally important. In the current study, students with poor diet quality were significantly more likely to consume meals and snacks away from home when compared to students with either average or superior diet quality. Consistent with previous reports (French et al., 2001), those that consumed meals or snacks from fast food restaurants or take out vendors had lower diet quality scores which represents lower intake of foods from CFGHE. However, results from the current study also indicated that it did not necessarily matter what type of location the meal or snack was consumed; those with poor diet quality consumed meals or snacks away from home, no matter the location, more frequently than those with higher diet quality scores. It is expected that higher frequencies of consuming foods at home would be associated with family meals, which has previously been associated with healthier diets (Larson et al., 2006).

A limitation of this study was the use of self-reported survey data. Like adults, many adolescents experience recall bias, response bias, and underreporting of total energy intake (Bandini et al., 2003; Livingstone et al., 1992). Adolescents are often affected by social desirability, however it has been shown that anonymity and privacy are important determinants when adolescents choose to report honest answers (Ginsburg et al., 1995; Supple, Aquilino, & Wright, 1999). Although the web-based survey provided anonymity and privacy, the 24-hour dietary recall was not facilitated by a trained interviewer. Therefore cues to promote cognitive processes were necessary which included portion size images and reminders of beverage intake. Reactivity was also decreased using the web-based survey as students were not aware in advance, what day the survey was to be completed.

In summary, Alberta and Ontario adolescents are consuming low intakes of foods found in CFGHE, while concurrently consuming high intakes of Other Foods. As a result, micronutrient intakes were sub-optimal. The high number of students with poor diet quality reflects the low micronutrient and food group intakes, meal skipping and increased meals away from home. Adolescents are at a life stage where they have increased autonomy regarding health behaviours. Many of the decisions and choices adolescents make may persist into adulthood and have lasting impact on long term health. Therefore, sub-optimal meal behaviours including meal skipping and consuming meals away from home should be targeted in order to promote consumption of foods found in CFGHE, which would result in an overall healthier diet.

4.6 References

Alberta Education. (2007a). Schools and School Boards. Retrieved February 7, 2007, from http://www.education.gov.ab.ca/ei/maps/

Alberta Education. (2007b). Statistics: Student Population. Retrieved August 1, 2007, from http://www.education.gov.ab.ca/ei/statistics/population.asp

Alberta Learning. (2002). Health and life skills, kindergarten to grade 9 [Electronic Version]. Retrieved December 7, 2006 from http://www.education.gov.ab.ca/k_12/curriculum/bySubject/healthpls/health.pdf.

Alberta Learning. (2005). Career and technology studies [Electronic Version]. Retrieved December 7, 2006 from http://www.education.gov.ab.ca/k%5F12/curriculum/bySubject/cts/foods/fodpos.pdf.

Albertson, A. M., Anderson, G. H., Crockett, S. J., & Goebel, M. T. (2003). Ready-to-eat cereal consumption: its relationship with BMI and nutrient intake of children aged 4 to 12 years. *Journal of the American Dietetic Association, 103*(12), 1613-1619.

Ball, G. D. C., & McCargar, L. J. (2003). Childhood obesity in Canada: a review of prevalence estimates and risk factors for cardiovascular diseases and type 2 diabetes. *Canadian Journal of Applied Physiology, 28*(1), 117-140.

Bandini, L. G., Must, A., Cyr, H., Anderson, S. E., Spadano, J. L., & Dietz, W. H. (2003). Longitudinal changes in the accuracy of reported energy intake in girls 10-15 y of age. *American Journal of Clinical Nutrition, 78*(3), 480-484.

Barr, S. I. (2006). Applications of Dietary Reference Intakes in dietary assessment and planning. *Applied Physiology, Nutrition and Metabolism, 31*(1), 66-73.

Basiotis, P., Lino, M., & Anand, R. S. (1999). Eating breakfast greatly improves schoolchildren's diet quality. *Family Economics and Nutrition Review, 12*(3&4), 81-83.

Burke, V. (2006). Obesity in childhood and cardiovascular risk. *Clinical and Experimental Pharmacology and Physiology, 33*(9), 831-837.

D'Alonzo, K. T. (2004). The Johnson-Neyman procedure as an alternative to ANCOVA. *Western Journal of Nursing Research, 26*(7), 804-812.

Dietz, W. H. (1998). Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics, 101*(3), 518-525.

ESHA Research. (1987 - 2002). The Food Processor, Nutrition Analysis and Fitness Software (Version 7.9). Salem, OR.

Fiore, H., Travis, S., Whalen, A., Auinger, P., & Ryan, S. (2006). Potentially protective factors associated with healthful body mass index in adolescents with obese and nonobese parents: a secondary data analysis of the third national health and nutrition examination survey, 1988-1994. *Journal of the American Dietetic Association, 106*(1), 55-64.

Freedman, D. S., Khan, L. K., Serdula, M. K., Dietz, W. H., Srinivasan, S. R., & Berenson, G. S. (2005). The relation of childhood BMI to adult adiposity: the Bogalusa Heart Study. *Pediatrics, 115*(1), 22-27.

French, S. A., Story, M., Neumark-Sztainer, D., Fulkerson, J. A., & Hannan, P. (2001). Fast food restaurant use among adolescents: associations with nutrient intake, food choices and behavioral and psychosocial variables. *International Journal of Obesity and Related Metabolic Disorders, 25*(12), 1823-1833.

Garriguet, D. (2004). Overview of Canadians' eating habits [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/82-620-MIE2006002.pdf.

Ginsburg, K. R., Slap, G. B., Cnaan, A., Forke, C. M., Balsley, C. M., & Rouselle, D. M. (1995). Adolescents' perceptions of factors affecting their decisions to seek health care. *Journal of the American Medical Association, 273*(24), 1913-1918.

Goran, M. I., Ball, G. D. C., & Cruz, M. L. (2003). Obesity and risk of type 2 diabetes and cardiovascular disease in children and adolescents. *Journal of Clinical Endocrinology & Metabolism, 88*(4), 1417-1427.

Gray-Donald, K., Jacobs-Starkey, L., & Johnson-Down, L. (2000). Food habits of Canadians: reduction in fat intake over a generation. *Canadian Journal of Public Health, 91*(5), 381-385.

Guo, S. S., Roche, A. F., Chumlea, W. C., Gardner, J. D., & Siervogel, R. M. (1994). The predictive value of childhood body mass index values for overweight at age 35 y. *American Journal of Clinical Nutrition, 59*, 810-819.

Guo, S. S., Wu, W., Chumlea, W. C., & Roche, A. F. (2002). Predicting overweight and obesity in adulthood from body mass index values in childhood and adolescence. *American Journal of Clinical Nutrition, 76*(3), 653-658.

Hanning, R., & Health Behaviour Research Group. (2004). University of Waterloo: Food Behaviour Survey.

Hanning, R., Lambraki, I., MacDonald, C., McCargar, L., Health Behaviour Research Group, & Beyond an Apple a Day Research Group. (2004). *A web-based approach to nutritional assessment in schools.* Paper presented at the International Congress of Dietetics, Chicago, Illinois.

Hanning, R. M., Jessup, L., Lambraki, I., MacDonald, C., & McCargar, L. (2003). *A web-based approach to assessment of food intake and behaviour of school children and adolescents.* Paper presented at the Canadian Foundation for Dietetic Research Symposium, Calgary, Alberta.

Health Canada. (1992). Canada's Food Guide to Healthy Eating [Electronic Version]. Retrieved December 7, 2006 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/fg_rainbow-arc_en_ciel_ga_e.pdf.

Health Canada. (2001). Canadian Nutrient File [Electronic Version] from http://www.hc-sc.gc.ca/food-aliment/ns-sc/nr-rn/surveillance/cnf-fcen/e_index.html.

Health Canada. (2007). Eating Well with Canada's Food Guide [Electronic Version]. Retrieved February 8, 2007 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/view_eatwell_vue_bienmang_e.pdf.

Institute of Medicine. (1997). *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Washington: National Academy Press.

Institute of Medicine. (1998). *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline*. Washington: National Academy Press.

Institute of Medicine. (2000a). *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. Washington: National Academy Press.

Institute of Medicine. (2000b). *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington: National Academy Press.

Institute of Medicine. (2000c). *Dietary Reference Intakes: Applications in Dietary Assessment*. Washington: National Academy Press.

Institute of Medicine. (2005). *Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients)*. Washington: National Academy Press.

Larson, N. I., Story, M., Wall, M., & Neumark-Sztainer, D. (2006). Calcium and dairy intakes of adolescents are associated with their home environment, taste preferences, personal health beliefs, and meal patterns. *Journal of the American Dietetic Association, 106*(11), 1816-1824.

Livingstone, M. B., Prentice, A. M., Coward, W. A., Strain, J. J., Black, A. E., Davies, P. S. W., Stewart, C. M., McKenna, P. G., & Whitehead, R. G. (1992). Validation of estimates of energy intake by weighed dietary record and diet history in children and adolescents. *American Journal of Clinical Nutrition, 56*(1), 29-35.

Lowik, M. R., Hulshof, K. F., & Brussaard, J. H. (1999). Food-based dietary guidelines: some assumptions tested for The Netherlands. *Br J Nutr, 81 Suppl 2*, S143-149.

Must, A., & Strauss, R. S. (1999). Risks and consequences of childhood and adolescent obesity. *International Journal of Obesity and Related Metabolic Disorders, 23 Suppl 2*, S2-S11.

Neumark-Sztainer, D., Story, M., Hannan, P. J., Perry, C. L., & Irving, L. M. (2002). Weight-related concerns and behaviors among overweight and nonoverweight adolescents: implications for preventing weight-related disorders. *Archives of Pediatrics and Adolescent Medicine, 156*(2), 171-178.

Neumark-Sztainer, D., Wall, M. M., Story, M., & Perry, C. L. (2003). Correlates of unhealthy weight-control behaviors among adolescents: implications for prevention programs. *Health Psychology, 22*(1), 88-98.

Nusser, S. M., Carriquiry, A. L., Dodd, K. W., & Fuller, W. A. (1996). A semiparametric transformation approach to estimating usual daily intake distributions. *Journal of the American Statistical Association, 91*(436), 1440-1449.

Ontario Ministry of Education. (2000). The Ontario curriculum, grades 11-12, Health and physical education [Electronic Version]. Retrieved December 7, 2006 from http://www.edu.gov.on.ca/eng/curriculum/secondary/health1112curr.pdf.

Ontario Ministry of Education. (2003a). Quick Facts. Retrieved June 17, 2003, from http://www.edu.gov.on.ca/eng/general/elemsec/quickfacts/2000-01/index.html

Ontario Ministry of Education. (2003b). School Board Profiles. Retrieved February 7, 2007, from http://esip.edu.gov.on.ca/english/core/BoardByBoundaryMap.asp

Ontario Ministry of Education. (2005). The Ontario curriculum, grades 1-8, Health and physical education [Electronic Version]. Retrieved December 7, 2006 from http://www.edu.gov.on.ca/eng/curriculum/elementary/health18curr.pdf.

Patricia, M. C. M., Waijers, P. M., Feskens, E. J., & Ocke, M. C. (2007). A critical review of predefined diet quality scores. *Br J Nutr, 97*(2), 219-231.

Rampersaud, G. C., Pereira, M. A., Girard, B. L., Adams, J., & Metzl, J. D. (2005). Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *Journal of the American Dietetic Association, 105*(5), 743-760.

Serdula, M. K., Ivery, D., Coates, R. J., Freedman, D. S., Williamson, D. F., & Byers, T. (1993). Do obese children become obese adults? A review of the literature. *Preventive Medicine, 22*(2), 167-177.

Shatenstein, B., Nadon, S., & Ferland, G. (2003). Diet quality among older Quebecers as assessed by simple indicators. *Can J Diet Pract Res, 64*(4), 174-180.

Shields, M. (2005). Measured obesity: Overweight Canadian children and adolescents [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/2005001/pdf/cobesity.pdf.

Supple, A. J., Aquilino, W. S., & Wright, D. L. (1999). Collecting sensitive self-report data with laptop computers: Impact on the response tendencies of adolescents in a home interview. *Journal of Research on Adolescence, 9*(4), 467-488.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate Statistics* (5th ed.). New York: Pearson Education, Inc.

Veugelers, P. J., Fitzgerald, A. L., & Johnston, E. (2005). Dietary intake and risk factors for poor diet quality among children in Nova Scotia. *Canadian Journal of Public Health, 96*(3), 212-216.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *The New England Journal of Medicine, 337*(13), 869-873.

Willett, W. (1998). *Nutritional epidemiology* (2nd ed.). New York: Oxford University Press.

Chapter 5: Reliability and validity of web-based survey methodology for assessing nutrition and physical activity behaviours and weight status of Alberta youth

5.1 Preface

The following chapter is based on data from in-school assessments and two self-administered web-based surveys that were conducted in the Edmonton area, within the province of Alberta. Grade 7 through 9 students (n = 459) participated. Data were examined to specifically investigate the reliability and validity of *Web-SPAN (Web-Survey of Physical Activity and Nutrition)*, a web-based survey that was developed at the University of Waterloo and modified by researchers at the University of Alberta. Data were collected between October and November 2005.

Prior to conducting this research study, the web-based tool used in the previous study (Chapter 4), the *Food Behaviour Questionnaire* developed at the University of Waterloo, was brought to the University of Alberta and modified by researchers at the University of Alberta. Over the period of one year, the survey was re-located on a new server and changes were made to reflect the interests of individual researchers. Due to the substantial changes made to the survey, and interest in assessing behaviours of both junior and senior high students, it was essential to assess the reliability and validity of the new survey tool, *Web-SPAN*.

5.2 Introduction

Web-based methods of surveillance provide unique opportunities to survey large numbers of participants concurrently throughout wide geographic areas. Access to hard-to-reach areas is enhanced, thus improving the ability to obtain a representative sample (Eaton & Struthers, 2002). Web-based surveys can also be tailored to specific populations or research by using enhanced pictures or interactive components that accompany the questionnaire or assessment methodology (Robinson et al., 2002). Other researchers have shown that when using a computer to collect data on health behaviours, 94% of adolescents 12 to 18 years of age (n = 98) found that answering a questionnaire using a computer was "easy", and 72% stated the computer was either "somewhat cool" or "very cool". No students found using the computer difficult (Robinson et al., 2002). Adolescents are likely to be familiar with computer and internet technology, especially in Alberta where the SuperNet was implemented in 2002, which provides high-speed internet service to thousands of facilities (government offices, schools, health care facilities, libraries) in 429 communities throughout the province of Alberta (Government of Alberta, 2002). Furthermore, the Household Internet Use Survey (2003) indicated that Alberta had one of the highest rates of internet use, where 58% of households were connected to the internet.

Some errors and bias are reduced when using web-based methodologies. Web-based surveys eliminate interviewer bias by standardizing the interaction a participant has with the survey. Data entry errors are also non-existent. Web-based methodologies utilize databases electronically linked to surveys, which eliminates the need for manual data entry (Rhodes, Bowie, & Hergenrather, 2003). Web-surveys also have been shown to increase the reporting of sensitive behaviours by adolescents (Webb, Zimet, Fortenberry, & Blythe, 1999). Web-surveys provide anonymity and privacy which other methods (such as face-to-face interviewing) do not allow. Although nutrition and physical activity behaviours are generally not thought of as sensitive behaviours, many adolescents have perceptions of socially desirable answers in regards to these behaviours (Brener, Billy, & Grady, 2003). It has been shown that anonymity and privacy are important determinants when adolescents choose to report honest answers (Ginsburg et al., 1995; Supple, Aquilino, & Wright, 1999). Reactivity can also be decreased when using web-based surveys, as researchers can establish a testing schedule in such a way that participants do not know the exact day on which the survey is going to take place. Furthermore, anonymity and privacy are extremely important when conducting research in schools, as many school administrators require surveys to be anonymous, making web-based surveys an attractive method for all individuals involved.

Although web-based surveys have many advantages when surveying large numbers of participants, there is less known about the reliability and validity of many of these survey instruments. Therefore, the purpose of this study was to assess the reliability and validity of an on-line Web-Survey of Physical Activity and Nutrition (Web-SPAN) used to assess nutrition, physical activity, and self-reported height and weight in a sample of Alberta students (grade seven to nine).

5.3 Methods

5.3.1 Participants

Ten schools within six school boards were selected for participation from a convenience sample of Edmonton area junior and senior high schools. School boards and schools were contacted by mail (detailed information package) (**Appendix C1, C2**) and follow-up phone contact was made to request permission to survey students in each school. Incentives were not used to obtain consent, however each participating student received a pedometer that was theirs to keep after the research concluded.

This research was approved by the University of Alberta Human Research Ethics Board in the Faculty of Agriculture, Forestry, and Home Economics (**Appendix D**), the Cooperative Activities Program in the Faculty of Education at the University of Alberta, and from each participating school board and school. Parents and students received information letters (**Appendix C3, C4**), and parental consent was obtained using active consent (**Appendix C5**). All students provided assent after logging on to the web-based survey (**Appendix C6**), and on the day of the in-school assessment (**Appendix C7**). Data collected between October and November 2005 are presented.

5.3.2 Procedures

Students that participated in this research completed two 24 paged web-based surveys (Web-Survey of Physical Activity and Nutrition (Web-SPAN); approximately 45 minutes each) an average of 7.8 days apart to determine the reliability of the web-survey tool. Test-retest reliability was measured by examining the relationship between time 1 and time 2 of the web-based survey (Web-SPAN) for self-reported height, weight and the on-line Physical Activity Questionnaire for Older Children (PAQ-C). In order to assess repeat comparisons of nutrient intakes (as measured using 24-hour recalls), time 1 and time 2 of the web-based survey were also used. To test the parallel-forms reliability of the on-line PAQ-C, time 1 of Web-SPAN was compared to a guided self-administered PAQ-C which was done as an in-school assessment (on average, 15.1 days after time 1 of the web-based survey).

In addition, to assess validity of the web-survey tool, students participated in additional in-school assessments (height, weight, a review of their 3-day food and pedometer record with researchers and a 20-metre shuttle run test (20mSRT)) that took approximately one hour per student. In-school assessments were completed, on average, 15.1 days after time 1 of the web-based survey. All data were collected during the school day. Time 1 of Web-SPAN and the in-school assessments were used to measure concurrent validity by examining self-reported height and weight (Web-SPAN) compared to measured height and weight (in-school assessment) and the on-line 24-hour recall (Web-SPAN) compared to the 3-day food record (in-school assessment). Three day averages of nutrient intakes were used for analyses. The on-line PAQ-C (time 1) was compared to both the 20mSRT (in-school assessment) and the 3-day pedometer record (in-school assessment) in order to assess convergent validity for physical activity measures.

Prevalence of non-overweight (which also includes non-obese), overweight, and obesity was assessed using self-reported height and weight and measured height and weight.

5.3.2.1 Web-Survey of Physical Activity and Nutrition (Web-SPAN)

The Web-Survey of Physical Activity and Nutrition was a web-based survey of grade seven through 10 students in the province of Alberta that assessed nutrition, physical activity, and self-reported height and weight. The web-survey instrument, the *Food Behaviour Questionnaire*, was developed at the University of Waterloo (Hanning, Jessup, Lambraki, MacDonald, & McCargar, 2003) and modified by researchers at the University of Alberta.

At the beginning of the survey, students provided self-reported height and weight. Body mass index was calculated (weight (kilograms)/height (meters^2)), and students were categorized as overweight or obese using the International Obesity Task Force (IOTF) cut-offs (Cole, Bellizzi, Flegal, & Dietz, 2000). A 24-hour dietary recall was administered to students to measure dietary intake using the web-based survey. Responding to the electronic survey questions, students reported all foods and beverages consumed during the previous day by selecting items from a list of approximately 500 foods. To help students recall their intake, portion size images and cues regarding beverage intake were provided. Students were able to add or delete items at any time throughout the 24-hour recall using the virtual meal plate and meal summary features. Macronutrient and micronutrient intakes were assessed using ESHA Food Processor version 7.9 (ESHA Research, 1987 - 2002) and the 2001b Canadian Nutrient File (Health Canada, 2001) database. A web-based version of the PAQ-C, as previously described, was used to assess physical activity levels over a seven-day period.

5.3.2.2 Anthropometry

Height and weight were measured by trained research staff, and were done in a private setting. All measurements were completed, on average, 15.1 days after time 1 of the web-based survey. Children were measured without shoes in light indoor clothing. Height was measured (to the nearest 0.1 cm) using a set square and tape measure. Weight was measured using a portable medical scale to the nearest 0.1 kg (Health o meter, Bridgeview, IL). Body mass index (BMI) was subsequently calculated (weight (kilograms)/height (meters^2)) using the students' height and weight measurements, and students were categorized as overweight or obese using the International Obesity Task Force (IOTF) cut-offs (Cole et al., 2000). Dietitians of Canada, the Canadian Paediatric Society, the College of Family Physicians of Canada, and the Community Health Nurses Association of Canada recommend the use of the IOTF cut-offs in group comparisons of overweight and obesity in youth (Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, & Community Health Nurses Association of Canada, 2004).

Additional anthropometric measurements which included waist circumference and bioelectrical impedance analysis were also measured and are presented in **Appendix E.**

5.3.2.3 Dietary Intake

Dietary intake was measured using a 3-day food record. Students recorded all foods and beverages consumed over a period of three days, which included one weekend day. All students were trained by research staff using both verbal and written communication (**Appendix F**) on correct record completion using food models, pictures, and sample records. Students learned about portion sizes, food preparation methods, and consuming meals away from home. Various pictures of portion size estimates were also included in the book students used to complete their 3-day food record (**Appendix F**). Students were instructed to continue usual eating habits throughout the measurement period. To further reduce error and to maximize accuracy and completeness, food records were reviewed with a trained dietary interviewer, immediately following data collection (on average, 15.1 days after time 1 of the web-based survey). The interviewer checked for completeness, clarified items and serving sizes, and provided cues to remind the participant of any foods or beverages mistakenly omitted (Willett, 1998).

The 3-day food records were entered into Food Processor by a registered dietitian using ESHA Food Processor version 9.8 (ESHA Research, 2004) and the 1997 Canadian Nutrient File (Health Canada, 1997) database. Three day averages of nutrient intakes were used for future analyses.

5.3.2.4 Physical Activity

5.3.2.4.1 Physical Activity Questionnaire for Older Children

The guided self-administered PAQ-C was used to assess physical activity levels over a seven-day period (**Appendix G**). The PAQ-C was specifically designed for Canadian school-aged youth, and includes components on physical activity during the school day as well as after school and weekend activity (Kowalski, Crocker, & Donen, 2004). The questionnaire consists of 10 items, of which 9 are used to calculate an activity score. Responses are converted to a 5-point scale where a higher score represents greater levels of physical activity (scores range from 1.00 to 5.00). The PAQ-C was found to be a reliable method to assess physical activity when test-retest reliability was examined over a period of one week in 84 boys (r = 0.75) and girls (r = 0.82) ages 9 to 14 years (Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997). Furthermore, the PAQ-C was found to be a valid measure in 9 to 14 year olds (n = 97) when compared to other physical activity assessment methods including an activity rating (r = 0.57), the Leisure Time Exercise Questionnaire (r = 0.41), a 7-day physical activity recall interview (r = 0.46), a Caltrac motion sensor (r = 0.39), and a Canadian Home Fitness Test (step test) of fitness (r = 0.28) (Kowalski, Crocker, & Faulkner, 1997).

Although the Physical Activity Questionnaire for Adolescents (PAQ-A) was developed specifically for use in the adolescent population, many rural Alberta schools still have daily recess. Therefore, students were given the option of selecting the answer that "they do not have recess" instead of using the PAQ-A which omits the activity at recess question from the PAQ-C.

5.3.2.4.2 Pedometer Record

The Yamax Digi-Walker SW-200 was used to objectively assess physical activity levels over the same three day period as the food record. The Yamax Digi-Walker was chosen because it has been validated for use in this population (Eston, Rowlands, & Ingledew, 1998; Kilanowski, Consalvi, & Epstein, 1999; Louie et al., 1999), and is a relatively inexpensive, reusable and reliable objective measure of physical activity (Sirard & Pate, 2001). Pedometers are digital devices that are generally worn on the hip and they can be used to estimate the number of steps taken over a period of time. Because pedometers register only vertical movements, they are unable to assess activities such as swimming, cycling, or movements of the upper body (e.g., rowing). Other estimates of activity (e.g., 10 minutes of activity = 1,000 steps) were used during these activities in order to assess total physical activity (Tudor-Locke & Bassett, 2004). Although there is some concern regarding reactivity in measuring devices, two studies have shown that reactivity does not exist when measuring activity levels in children with both unsealed (Ozdoba, Corbin, & Masurier, 2004) and sealed (Vincent & Pangrazi, 2002) pedometers; therefore pedometers were left unsealed for data collection. All participants were instructed by research staff on correct pedometer placement, step recording and care. Reminders in the 3-day record book were included to trigger students to reset their pedometer at the beginning of the day and to record their steps at the end of the day.

5.3.2.5 Physical Fitness

The 20-metre shuttle run test (20mSRT) is a well-established fitness assessment that was developed by Léger and Lambert (1982) and has been found to be a reliable and valid method of fitness assessment in youth (Boreham, Paliczka, & Nichols, 1990; Boreham, Twisk, Savage, Cran, & Strain, 1997; Léger, Mercier, Gadoury, & Lambert, 1988; Liu, Plowman, & Looney, 1992; Mahoney, 1992; McVeigh, Payne, & Scott, 1995). Separated by stages, each increase in stage has a one metabolic equivalent (MET) increase. One MET (3.5 ml O2 / kg * min) can be described as "the energy (oxygen) used by the body as you sit quietly" (Centers for Disease Control and Prevention, 2006, para. 5). Examples of activities at one MET include reading or talking on the phone. During the 20mSRT participants run between parallel lines 20-meters apart. The pace is indicated by signals provided on an audiocassette, with a starting speed of 8.5 kilometers/hour, which increases by 0.5 kilometers/hour every minute. The test ends for an individual when they become too exhausted to continue, or when a participant is greater than two steps away from the 20-metre line at the time of the signal. Researchers record the last stage completed by the participant (0.0 to 20.0). This can then be converted to running speed at the last completed one-minute stage in order to determine levels of fitness, with higher scores reflecting a higher level of cardiorespiratory fitness.

There are many advantages of the 20mSRT compared to other fitness tests, such as distance runs. The space required to complete the 20mSRT is not extensive and therefore it can be carried out indoors, including most school gymnasiums. This removes the variability that could potentially result from seasonal outdoor testing.

5.3.2.6 Statistical Analyses

Reliability and validity analyses were completed using intraclass correlation coefficients (ICC), Pearson product moment correlations and paired samples t-tests. Overweight and obesity prevalence was analyzed using descriptive statistics. Test-retest reliability was done using time 1 and time 2 of Web-SPAN, while validity was assessed using measures from time 1 of Web-SPAN and the in-school assessments. Statistical analyses were performed using the software program SPSS (version 15.0; SPSS Inc, Chicago). A criterion α-level of $p < 0.05$ was used for all statistical comparisons.

5.4 Results

5.4.1 Demographics

There were 547 students out of a possible 903 (61%) students that consented to participate in the research study. Students that consented but did not complete the research study (n = 28), and students with extreme values of total caloric intake, BMI, height, weight, physical activity and pedometer steps based on outlier analyses (web-survey, n = 14; in-school assessments, n = 3; web-survey/in-school assessments, n = 43; total outliers removed, n = 60) were excluded. Thus, a final sample of 459 (50.8%) adolescents was included in the analyses (boys = 225; girls = 233; mean age = 12.8 years). During data collection, students were free to end the web-based survey or in-school assessments at any time. Therefore, sample size varies throughout the analyses. A total of seven schools (70%) within five school boards agreed to participate. At study completion a total of four schools within three school boards participated in the research project, representing a 40% response rate at the school level. Reasons for refusal were generally due to time constraints throughout the school year.

5.4.2 Anthropometry

5.4.2.1 Height and Weight

Students that completed Web-SPAN twice (an average of 7.8 days apart) were assessed for test-retest reliability for both height (n = 299) and weight (n = 333). Mean differences at time 1 and time 2 for both height (-0.12 cm) and weight (-0.14 kg) were very small, and thus values were highly correlated. There were no significant differences for either self-reported height (time 1 = 160.4 ± 10.1 cm; time 2 = 160.6 ± 10.2 cm) ($t = -0.47$; $p = 0.638$) or weight (time 1 = 49.1 ± 10.1 kg; time 2 = 49.2 ± 10.1 kg) ($t = -1.43$; $p = 0.154$) when assessed using a paired samples t-test. Results from the reliability analyses are presented in **Table 5.1**.

Intraclass correlation coefficients between self-reported and measured height was 0.88, where the mean self-reported height was 160.8 cm and the mean measured height was 160.4 cm (self-reported = 160.8 ± 10.3 cm; measured = 160.4 ± 9.1 cm) ($t = 1.78$; $p = 0.076$) ($n = 364$) (**Table 5.1**). The ICC between self-reported and measured weight was 0.93. Mean self-reported weight was 49.7 kg, while the mean measured weight was 52.2 kg (self-reported = 49.7 ± 10.6 kg; measured = 52.2 ± 11.7 kg) ($t = -12.18$; $p < 0.001$) ($n = 409$). Results from the validity analyses are presented in **Table 5.1** based on self-report versus measured values.

Table 5.1: Intraclass Correlation Coefficients (ICC), Pearson r, and Paired T-Tests for Time 1[*] vs. Time 2[*] and Reported vs. Measured Heights and Weights

	ICC[†]	Pearson r[†]	Paired t-test	
			Mean Difference	P Value
Height Time 1 vs. Height Time 2 (cm)	0.90	0.90	-0.12	0.638
Weight Time 1 vs. Weight Time 2 (kg)	0.98	0.98	-0.14	0.154
Reported Height vs. Actual Height (cm)	0.88	0.88	0.45	0.076
Reported Weight vs. Actual Weight (kg)	0.93	0.94	-2.47	< 0.001

[*] Time 1 and Time 2 reflect self-reported values and were used for the test-retest reliability analyses

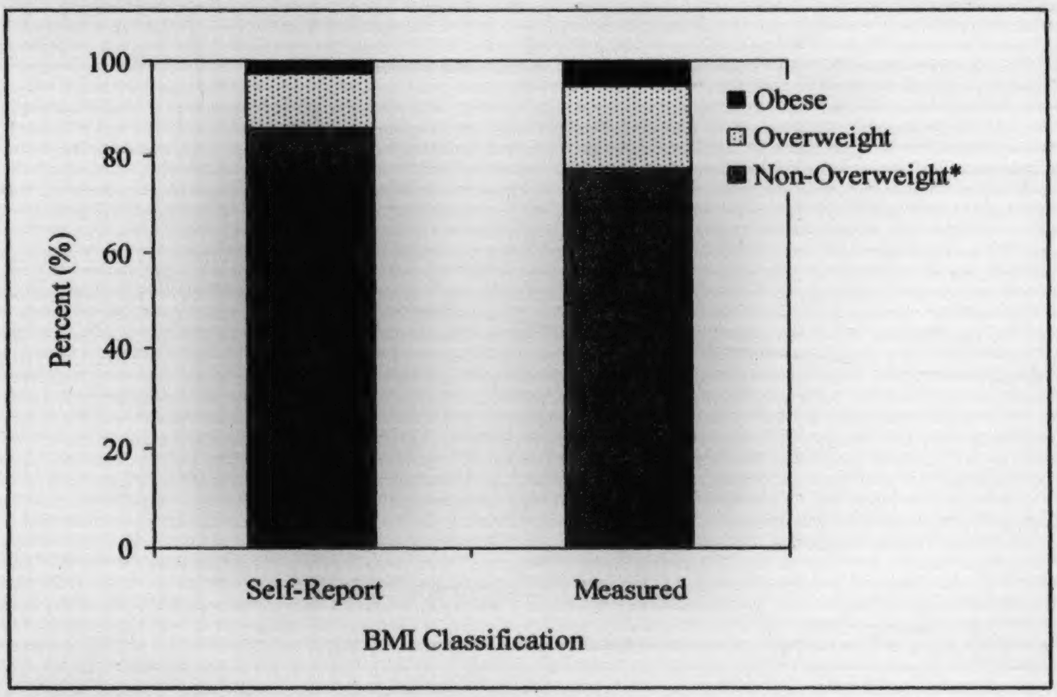
[†] All correlations were significant at $p < 0.001$

Abbreviations: ICC (intraclass correlation coefficient), cm (centimeters), kg (kilograms)

5.4.2.2 BMI Classification

Observed prevalence of overweight and obesity, using both self-reported and measured height and weight, are presented in **Figure 5.1.** When using self-reported height and weight, 12% (n = 40) of students were considered overweight, while 3% (n = 9) of students were considered obese. Body mass index classification using measured height and weight, was significantly different with 17% (n = 59) of students classified as overweight and 6% (n = 19) of students classified as obese (χ^2 (4, n = 348) = 193.87; $p < 0.001$). Overall, an 84% agreement was observed between BMI classification based on self-report versus measured height and weight.

Figure 5.1: BMI Classifications using Self-Reported Height and Weight Compared to Measured Height and Weight



*Non-overweight refers to all non-overweight and non-obese students
Abbreviation: BMI (body mass index)

5.4.3 Dietary Intake

Repeat comparisons of nutrient intakes (as measured using 24-hour recalls), completed an average of 7.8 days apart, showed overall good agreement, where ICC values of selected nutrients ranged from 0.37 to 0.64, and Pearson r values ranged from 0.38 to 0.64 (n = 379). Correlations were generally stronger for macronutrients than micronutrients. Significant differences were not observed based on paired t-test for vitamin A, iron, and niacin; all other paired t-tests were significant (**Table 5.2**).

Table 5.2: Intraclass Correlation Coefficients (ICC), Pearson r, and Paired T-Tests for Time 1 vs. Time 2 Web-Based 24-Hour Dietary Recall

Time 1[*] vs. Time 2[*]	ICC[†]	Pearson r[†]	Paired t-test	
			Mean Difference	P Value
Total energy (kcals)	0.64	0.64	196.50	< 0.001
Carbohydrates (g)	0.61	0.62	29.57	< 0.001
Protein (g)	0.55	0.55	5.63	0.010
Fat (g)	0.56	0.56	6.57	0.004
Fibre (g)	0.45	0.45	1.67	0.001
Vitamin A (μg)	0.38	0.38	1.37	0.727
Vitamin C (mg)	0.37	0.38	21.38	0.003
Iron (mg)	0.50	0.50	0.37	0.314
Niacin (mg)	0.41	0.41	0.93	0.162
Zinc (mg)	0.46	0.46	0.82	0.012
Calcium (mg)	0.62	0.62	102.04	0.002
Vitamin D (μg)	0.54	0.54	0.55	0.026

[*] 24-hour dietary recall assessed using Web-SPAN

[†] All correlations were significant at $p < 0.001$

Abbreviations: ICC (intraclass correlation coefficient), kcals (kilocalories), g (grams), μg (micrograms)

Intraclass correlation coefficients between the web-based 24-hour dietary recall and the 3-day food record varied from 0.16 to 0.34 (n = 369). Although correlations were weak, mean differences between the two measures were small. Significant differences were not observed for fat, iron, and niacin based on paired t-tests; all other paired t-test comparisons were significant (**Table 5.3**).

Table 5.3: Intraclass Correlation Coefficients (ICC), Pearson r, and Paired T-Tests for a Web-Based 24-Hour Dietary Recall vs. 3-Day Food Record

24-hour recall[*] vs. 3-day food record	ICC[†]	Pearson r[‡]	Paired t-test	
			Mean Difference	P Value
Total energy (kcals)	0.31	0.33	161.59	0.001
Carbohydrates (g)	0.26	0.28	30.32	< 0.001
Protein (g)	0.35	0.37	4.51	0.032
Fat (g)	0.27	0.29	3.23	0.168
Fibre (g)	0.26	0.28	2.12	< 0.001
Vitamin A (µg)	0.16	0.17	-27.65	< 0.001
Vitamin C (mg)	0.20	0.22	37.86	< 0.001
Iron (mg)	0.33	0.34	-0.04	0.914
Niacin (mg)	0.30	0.33	1.10	0.057
Zinc (mg)	0.32	0.33	0.71	0.019
Calcium (mg)	0.31	0.33	119.69	0.001
Vitamin D (µg)	0.34	0.36	1.27	< 0.001

[*] 24-hour dietary recall assessed using Web-SPAN

[†] With exception to vitamin A ($p = 0.006$), all correlations were significant at $p < 0.001$

[‡] With exception to vitamin A ($p = 0.008$), all correlations were significant at $p < 0.001$

Abbreviations: ICC (intraclass correlation coefficient), kcals (kilocalories), g (grams), µg (micrograms)

5.4.4 Physical Activity and Physical Fitness

Students who completed Web-SPAN twice were assessed for test-retest reliability of the on-line PAQ-C. Intraclass correlations coefficients were strong at 0.79. Significance was observed based on the paired samples t-test, however mean values for time 1 (3.05 ± 0.61) and time 2 (2.95 ± 0.63) were similar and were completed an average of 7.8 days apart ($n = 323$) **(Table 5.4)**.

Parallel forms reliability was measured using an on-line version of the PAQ-C compared to the guided self-administered PAQ-C. Mean differences were small, and no significant difference was observed between the two methods (web-based PAQ-C = 3.05 ± 0.62; paper-based PAQ-C = 3.07 ± 0.61) ($t = -0.73$; $p = 0.464$) ($n = 411$) **(Table 5.4)**.

Table 5.4: Intraclass Correlation Coefficients (ICC), Pearson r, and Paired T-Tests for the Time 1* vs. Time 2* PAQ-C and Web-Based PAQ-C vs. a Paper-Based PAQ-C†

	ICC‡	Pearson r‡	Paired t-test	
			Mean Difference	P Value
Time 1 PAQ-C vs. Time 2 PAQ-C	0.79	0.79	0.11	< 0.001
Web-Based PAQ-C vs. Paper-Based PAQ-C	0.70	0.70	-0.02	0.464

*Time 1 and Time 2 reflect web-based PAQ-C values
†The paper-based PAQ-C was a guided self-administered assessment
‡All correlations were significant at $p < 0.001$
Abbreviations: ICC (intraclass correlation coefficients), PAQ-C (Physical Activity Questionnaire for Older Children)

Convergent validity was assessed by comparing the web-based PAQ-C to either a 20mSRT or a 3-day pedometer record. The 20-metre shuttle run test (20mSRT) is a well-established fitness assessment, while pedometer steps were used to objectively assess physical activity levels over a three day period. Pedometer steps (3 days of steps) were averaged prior to analysis. Pearson's r were weak when comparisons were made between the web-based PAQ-C and either the 20mSRT ($r = 0.28$) ($n = 391$) or the 3-day pedometer record ($r = 0.28$) ($n = 342$) (**Table 5.5**).

Table 5.5: Pearson Correlations for a Web-Based PAQ-C* vs. 20-Metre Shuttle Run Test (20mSRT) and Pedometer Steps

	Pearson r†
Web-Based PAQ-C vs. 20mSRT	0.28
Web-Based PAQ-C vs. Pedometer Steps	0.28

*The web-based PAQ-C refers to time 1
†Correlations were significant at $p < 0.001$
Abbreviation: PAQ-C (Physical Activity Questionnaire for Older Children), 20mSRT (20-metre shuttle run test)

5.5 Discussion

Web-based methods of surveillance allow researchers to survey large numbers of participants concurrently throughout wide geographic areas. Further, adolescents are likely to be familiar with computer and internet technology, and have previously indicated that they do not find using the computer difficult (Robinson et al., 2002). Web-based methods of data collection are also attractive because errors and bias are often reduced (Rhodes et al., 2003).

5.5.1 Anthropometry

Results from the analyses examining test-retest reliability of self-reported height and weight (completed an average of 7.8 days apart) and self-reported height and weight compared to measured height and weight revealed strong correlations. The only significant difference was between self-reported weight and measured weight, where the mean difference was -2.47 kg, suggestive of under-reporting. This difference likely accounted for the discrepancy in overweight and obesity prevalence when using both self-reported and measured values due to lower average BMI values. Mean differences between self-reported height and measured height, and test-retest height and weight were very small and thus values were highly correlated.

The results of the current study are similar to other studies, indicating that self-report is a reliable measure to assess weight status in youth. Strauss (1999) examined measured and self-reported heights and weights in a sample of 1,657 adolescents ages 12 to 16 years that were enrolled in the NHANES III study. Correlations between self reported weight and actual weight ranged between 0.87 and 0.94 depending on gender and ethnicity. Utilizing a similar sample of adolescents (n = 1,635) from the NHANES III study, Himes and Faricy (2001) investigated the validity and reliability of self-reported height and weight in adolescents ages 12 to 16 years and found that the intraclass coefficients between measured and self-reported data in 14 to 16 year olds ranged from 0.81 to 0.91 and 0.92 to 0.98 for height and weight respectively. A more recent study of grade 9 through 12 students (n = 4,619) living throughout the United States examined self-reported height and weight and determined that self-reported height and weight at time 1 and time 2 were highly correlated (r = 0.93 for both height and weight). Further, the correlations between self-reported and measured heights and weights were 0.90 and 0.93 respectively (Brener, McManus, Galuska, Lowry, & Wechsler, 2003). The University of Waterloo web-based survey found similar results, showing that height and weight reported by grade 6 through 8 students (n = 51) was highly correlated with measured height (r = 0.84) and weight (r = 0.94). Interclass correlation estimates also showed good agreement for height (80%) and weight (87%) (Hanning et al., 2003).

Self-reported height and weight are often used to determine BMI, which is then used to determine overweight and obesity status in epidemiological and other research studies. Self-reported data offers researchers a time- and cost-effective method to survey a large number of participants simultaneously, and has been found to be a reliable and valid measure in numerous studies including the current study. Although measured height and weight are more precise and accurate than self-reported measurements, self-report is a useful method that can be used in cross-sectional studies in order to determine obesity-related behaviours.

5.5.2 Dietary Intake

Repeat comparisons of the web-based 24-hour dietary recall produced good correlations for nutrient intakes where macronutrients generally had stronger agreements than micronutrients. Correlations for the web-based 24-hour dietary recall and the 3-day food record were weak, although this is likely due to the considerable variation in nutrient intake within individuals. Usual intake cannot be determined using a one-day measure, and it is therefore difficult to compare dietary intakes on different days. The *Food Behaviour Questionnaire* has been previously validated using several methods. In comparison to a dietitian-administered 24-hour dietary recall, the *Food Behaviour Questionnaire* showed good agreement for total caloric intake, carbohydrates, protein, fat, fibre, and key micronutrients when assessed over the same 24-hour period in grade 6 to 8 students (n = 51) (Hanning & Health Behaviour Research Group, 2004). In comparison to direct observation of food items selected at lunch hour versus those selected on the web-survey, grade 9 and 10 students (n = 15) showed an overall agreement of 87% (Hanning et al., 2004). Although the correlations in the current study were not as strong as those provided in previous reports (Hanning & Health Behaviour Research Group, 2004), this may be due to methodological differences. The current study utilized 3-day food records, generally considered the gold standard in dietary assessment (Rockett & Colditz, 1997). These were completed on days that did not correspond to days of the web-based survey, whereas the previous report used a traditional dietitian-administered 24-hour dietary recall on the same day as the web-based survey.

Although the food record is considered the gold standard in dietary assessment (Rockett & Colditz, 1997), errors and bias often occur. Subjects keep detailed dietary records for a period of one or more days, and therefore must be trained and motivated to successfully complete the record. Subjects are also often affected by social desirability, where they feel the need to provide others with a favourable impression of oneself (Brener, Billy et al., 2003). This can lead to intentional omission of foods deemed socially unacceptable, or "unhealthy", by the subject. Additional error can be linked to a lack of motivation of the subject. Because of the high subject burden during transcription of foods, individuals may choose to reduce intake or not to record food items in order to decrease the amount of effort required to complete a food record (Willett, 1998).

In comparison to the web-based 24-hour dietary recall, the 3-day food record produced lower estimates of nutrient intakes with the exception of vitamin A and iron. A potential explanation for these differences may be in part due to subject burden, where students may have chosen to reduce intake in order to decrease effort in completing the food record. In addition, the food records were reviewed with a member of the research staff which could have led to the intentional omission of foods deemed socially unacceptable by the subject. Because the web-based method provided anonymity and privacy, the reporting of "unhealthy" foods may have been higher.

Due to the attractiveness of collecting dietary intake data using web-based methodology, many organizations are moving towards the use of computer- and web-based tools and surveys such as Dietitians of Canada (EATracker) and the Dole 5 a Day Virtual Classroom (DiSogra & Glanz, 2000). Another computer-based dietary assessment tool, the Food Intake Record Software System (FIRSSt), was found to be a promising method when compared with direct observation during a lunch period and a dietitian administered 24-hour recall with 138 fourth grade students (Baranowski et al., 2002). When compared to written self-administered questionnaires, a Computer Assisted Self-Interview (CASI) showed no significant differences between self-reported and computer assisted assessment methods for physical activity and eating habits (Webb et al., 1999).

Although web-based methodologies used to assess nutrient intakes are gaining popularity, each method of dietary assessment has its own strengths, limitations and techniques. Subject burden, training, measurement error and population-specific barriers are all important considerations that must be evaluated before selecting a method of dietary assessment. While the food record may be considered the gold standard in dietary assessment, it is more time consuming and has a higher subject burden compared to the 24-hour dietary recall.

5.5.3 Physical Activity and Physical Fitness

The PAQ-C is a guided self-administered questionnaire used to assess moderate to vigorous physical activity levels over a seven-day period (Kowalski et al., 2004). Because the PAQ-C is a paper-based questionnaire, it was important to determine the reliability of this questionnaire when used in an on-line survey. The on-line PAQ-C produced strong correlations (0.79) when test-retest reliability was examined. This is consistent with previous reports that examined the test-retest reliability of the paper-based PAQ-C over a period of one week in 84 boys (r = 0.75) and girls (r = 0.82) ages 9 to 14 years (Crocker et al., 1997). Results from the current study also indicated that the on-line PAQ-C revealed strong correlations (0.70) when compared to the paper-based PAQ-C, demonstrating the utility of using a web-based survey method.

Although subjective methods such as the PAQ-C or the PAQ-A can be used to assess physical activity, there are other methods that do not rely on self-report. Objective methods such as activity monitors (e.g., pedometers) can be used to gain a more direct understanding of physical activity levels in youth. Compared to the on-line PAQ-C, the pedometer revealed weak correlations. This is consistent with previous studies that compared the paper-based PAQ-C to other activity monitors (Caltrac motion sensor) (Kowalski et al., 1997); as many self-reported measures are weakly correlated to objective measuring devices. The pedometer is a very useful measuring device, however pedometers register only vertical movements, thus they are unable to assess activities such as swimming, cycling, or movements of the upper body (e.g., rowing). Although other estimates of activity were used during these types of activities in the current study (i.e. 10 minutes of activity = 1,000 steps), total physical activity may not have been accurately reported.

The 20mSRT is a well-established fitness assessment that was originally developed by Léger and Lambert (1982) to simulate a graded exercise test in adults. The on-line PAQ-C was weakly correlated with the 20mSRT, which is consistent with previous reports that examined the paper-based PAQ-C compared to other fitness assessments (Canadian Home Fitness Test (step test) of fitness) (Kowalski et al., 1997). This is expected, as it is known that physical activity is only weakly correlated with physical fitness.

The PAQ-C is used to generate an activity score which creates a composite score that helps to prevent outliers and gives researchers the ability to differentiate between high and low active children. Results from the current study indicate that the on-line PAQ-C is a reliable method that can be used to assess physical activity levels in adolescents.

In summary, results from the current study indicate that although measured height and weight are more precise and accurate than self-reported measurements, self-report is a useful and reliable method that can be used in cross-sectional studies in order to determine obesity-related behaviours. In addition, the on-line PAQ-C was shown to be a reliable method that can be used to assess physical activity. Although the correlations between the on-line 24-hour dietary recall and the 3-day food record were weak, the on-line survey had a much lower subject burden, and may have even increased the reporting of "unhealthy" foods. Additionally, repeat comparisons for the on-line 24-hour dietary recall were good, indicating the appropriateness of using this method at different time points. Furthermore, anonymity and privacy are extremely important when conducting research in schools, as many school administrators require surveys to be anonymous. Although there are challenges when using self-reported data, the adaptability and flexibility of web-based tools makes the internet an efficient, cost effective and practical solution when collecting and managing data.

5.6 References

Baranowski, T., Islam, N., Baranowski, J., Cullen, K. W., Myres, D., Marsh, T., & de Moor, C. (2002). The food intake recording software system is valid among fourth-grade children. *Journal of the American Dietetic Association, 102*(3), 380-385.

Boreham, C. A., Paliczka, V. J., & Nichols, A. K. (1990). A comparison of the PWC_{170} and 20-MST tests of aerobic fitness in adolescent schoolchildren. *Journal of Sports Medicine and Physical Fitness, 30*(1), 19-23.

Boreham, C. A., Twisk, J., Savage, M. J., Cran, G. W., & Strain, J. J. (1997). Physical activity, sports participation, and risk factors in adolescents. *Medicine and Science in Sports and Exercise, 29*(6), 788-793.

Brener, N. D., Billy, J. O. G., & Grady, W. R. (2003). Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *Journal of Adolescent Health, 33*(6), 436-457.

Brener, N. D., McManus, T., Galuska, D. A., Lowry, R., & Wechsler, H. (2003). Reliability and validity of self-reported height and weight among high school students. *Journal of Adolescent Health, 32*(4), 281-287.

Centers for Disease Control and Prevention. (2006, March 22, 2006). Physical activity for everyone: Measuring physical activity intensity. from http://www.cdc.gov/nccdphp/dnpa/physical/measuring/index.htm

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal (clinical research ed.), 320*(7244), 1240-1243.

Crocker, P. R. E., Bailey, D. A., Faulkner, R. A., Kowalski, K. C., & McGrath, R. (1997). Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children. *Medicine and Science in Sports and Exercise, 29*(10), 1344-1349.

Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, & Community Health Nurses Association of Canada. (2004). The use of growth charts for assessing and monitoring growth in Canadian infants and children. *Canadian Journal of Dietetic Practice and Research, 65*(1), 22-32.

DiSogra, L., & Glanz, K. (2000). The 5 A day Virtual Classroom: an on-line strategy to promote healthful eating. *Journal of the American Dietetic Association, 100*(3), 349-352.

Eaton, J., & Struthers, C. W. (2002). Using the internet for organizational research: a study of cynicism in the workplace. *CyberPsychology and Behavior, 5*(4), 305-313.

ESHA Research. (1987 - 2002). The Food Processor, Nutrition Analysis and Fitness Software (Version 7.9). Salem, OR.

ESHA Research. (2004). The Food Processor, Nutrition Analysis and Fitness Software (Version 9.8). Salem, OR.

Eston, R. G., Rowlands, A. V., & Ingledew, D. K. (1998). Validity of heart rate, pedometry, and accelerometry for predicting the energy cost of children's activities. *Journal of Applied Physiology, 84*(1), 362-371.

Ginsburg, K. R., Slap, G. B., Cnaan, A., Forke, C. M., Balsley, C. M., & Rouselle, D. M. (1995). Adolescents' perceptions of factors affecting their decisions to seek health care. *Journal of the American Medical Association, 273*(24), 1913-1918.

Government of Alberta. (2002). Alberta SuperNet. Retrieved December 10, 2006, from http://www.albertasupernet.ca/

Hanning, R., & Health Behaviour Research Group. (2004). University of Waterloo: Food Behaviour Survey.

Hanning, R., Lambraki, I., MacDonald, C., McCargar, L., Health Behaviour Research Group, & Beyond an Apple a Day Research Group. (2004). *A web-based approach to nutritional assessment in schools.* Paper presented at the International Congress of Dietetics, Chicago, Illinois.

Hanning, R. M., Jessup, L., Lambraki, I., MacDonald, C., & McCargar, L. (2003). *A web-based approach to assessment of food intake and behaviour of school children and adolescents.* Paper presented at the Canadian Foundation for Dietetic Research Symposium, Calgary, Alberta.

Health Canada. (1997). Canadian Nutrient File [Electronic Version] from http://www.hc-sc.gc.ca/food-aliment/ns-sc/nr-rn/surveillance/cnf-fcen/e_index.html.

Health Canada. (2001). Canadian Nutrient File [Electronic Version] from http://www.hc-sc.gc.ca/food-aliment/ns-sc/nr-rn/surveillance/cnf-fcen/e_index.html.

Himes, J. H., & Faricy, A. (2001). Validity and reliability of self-reported stature and weight of US adolescents. *American Journal of Human Biology, 13*(2), 255-260.

Kilanowski, C. K., Consalvi, A. R., & Epstein, L. H. (1999). Validation of an electronic pedometer for measurement of physical activity in children. *Pediatric Exercise Science, 11*, 63-68.

Kowalski, K. C., Crocker, P. R. E., & Donen, R. M. (2004). The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) manual [Electronic Version] from http://hkin.educ.ubc.ca/behavioural/PAQ%20manual.pdf.

Kowalski, K. C., Crocker, P. R. E., & Faulkner, R. A. (1997). Validation of the Physical Activity Questionnaire for Older Children. *Pediatric Exercise Science, 9*, 174-186.

Léger, L. A., & Lambert, J. (1982). A maximal multistage 20-m shuttle run test to predict VO2 max. *European Journal of Applied Physiology and Occupational Physiology, 49*(1), 1-12.

Léger, L. A., Mercier, D., Gadoury, C., & Lambert, J. (1988). The multistage 20 metre shuttle run test for aerobic fitness. *Journal of Sports Sciences, 6*(2), 93-101.

Liu, N. Y.-S., Plowman, S. A., & Looney, M. A. (1992). The reliability and validity of the 20-meter shuttle test in American students 12 to 15 years old. *Research Quarterly for Exercise and Sport, 63*(4), 360-365.

Louie, L., Eston, R. G., Rowlands, A. V., Tong, K. K., Ingledew, D. K., & Fu, F. H. (1999). Validity of heart rate, pedometry, and accelerometry for estimating the energy cost of activity in Hong Kong Chinese boys. *Pediatric Exercise Science, 11*, 229-239.

Mahoney, C. (1992). 20-MST and PWC_{170} validity in non-Caucasian children in the UK. *British Journal of Sports Medicine, 26*(1), 45-47.

McVeigh, S. K., Payne, A. C., & Scott, S. (1995). The reliability and validity of the 20-meter shuttle test as a predictor of peak oxygen uptake in Edinburgh school children, age 13 to 14 years. *Pediatric Exercise Science, 7*, 69-79.

Ozdoba, R., Corbin, C., & Masurier, G. L. (2004). Does reactivity exist in children when measuring activity levels with unsealed pedometers? *Pediatric Exercise Science, 16*, 158-166.

Rhodes, S. D., Bowie, D. A., & Hergenrather, K. C. (2003). Collecting behavioural data using the world wide web: considerations for researchers. *Journal of Epidemiology and Community Health, 57*(1), 68-73.

Robinson, E. M., Watson, P. D., Clark, T. C., Ameratunga, S. N., Denny, S. J., Adair, V., Crengle, S. M., Dixon, R. S., Fa'asisila, M., Merry, S. N., & Sporle, A. A. (2002). *The development and administration of a population based Multimedia Computer Assisted Self Interview (M-CASI) adolescent health survey.* Paper presented at The International Conference on Improving Surveys, University of Copenhagen, Denmark.

Rockett, H. R. H., & Colditz, G. A. (1997). Assessing diets of children and adolescents. *American Journal of Clinical Nutrition, 65*(4 Suppl), 1116S-1122S.

Sirard, J. R., & Pate, R. R. (2001). Physical activity assessment in children and adolescents. *Sports Medicine, 31*(6), 439-454.

Statistics Canada. (2003). Household internet use survey - microdata user's guide [Electronic Version] from http://www.statcan.ca/english/freepub/56M0002GIE/56M0002GIE2004001.pdf.

Strauss, R. S. (1999). Comparison of measured and self-reported weight and height in a cross-sectional sample of young adolescents. *International Journal of Obesity and Related Metabolic Disorders, 23*(8), 904-908.

Supple, A. J., Aquilino, W. S., & Wright, D. L. (1999). Collecting sensitive self-report data with laptop computers: Impact on the response tendencies of adolescents in a home interview. *Journal of Research on Adolescence, 9*(4), 467-488.

Tudor-Locke, C., & Bassett, D. R., Jr. (2004). How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Medicine, 34*(1), 1-8.

Vincent, S. D., & Pangrazi, R. P. (2002). Does reactivity exist in children when measuring activity levels with pedometers? *Pediatric Exercise Science, 14*, 56-63.

Webb, P. M., Zimet, G. D., Fortenberry, J. D., & Blythe, M. J. (1999). Comparability of a computer-assisted versus written method for collecting health behavior information from adolescent patients. *Journal of Adolescent Health, 24*(6), 383-388.

Willett, W. (1998). *Nutritional epidemiology* (2nd ed.). New York: Oxford University Press.

Chapter 6: Nutrition, physical activity and diet quality among Alberta adolescents as assessed by the Web-Survey of Physical Activity and Nutrition (Web-SPAN)

6.1 Preface

The following chapter is based on data from a self-administered web-based survey that was conducted in the province of Alberta. Grade 7 through 10 students (n = 4936) participated. Data were examined to specifically investigate diet quality and physical activity of the students. Data were collected between January and November 2005 using *Web-SPAN (Web-Survey of Physical Activity and Nutrition)*, a web-based survey that was developed at the University of Waterloo and modified by researchers at the University of Alberta.

This study was the first study conducted using the new web-based survey methodology, *Web-SPAN*. Building on the foundation and feasibility of the first web-based survey (Chapter 4), the present study aimed to investigate adolescents in both junior and senior high in order to gain a better understanding of the current nutrition and physical activity status of Alberta adolescents. All Alberta school boards were invited to participate so as to maximize recruitment.

6.2 Introduction

National surveys have indicated that Canadian adolescents have sub-optimal nutritional intakes and low levels of physical activity (Canadian Fitness and Lifestyle Research Institute, 2006; Garriguet, 2004; Shields, 2005). Although these results have provided insight into the current health behaviours of Canadian adolescents, less is known about the overall diet quality of this population based on adherence to recommendations established by Canada's Food Guide to Healthy Eating (CFGHE). Although each food group is individually important, total health and wellness relies on the appropriate balance and variety of all four food groups (Health Canada, 1992) as well as adequate levels of physical activity (Health Canada and the Canadian Society for Exercise Physiology, 2002). Further, the relationship between diet quality and nutrient intakes, meal behaviours and physical activity are not well understood as surveys that have assessed these health behaviours, did not do so simultaneously which does not allow for comparisons between these behaviours.

Unhealthy diets and physical inactivity have been established as important determinants of rising prevalence of overweight and obesity (Raine, 2004; Shields, 2005). Over the past 25 years the prevalence of overweight nearly doubled among adolescents in Canada from 11% to 20% while obesity rates tripled from 3% to 9% (Shields, 2005). There are a number of consequences of adolescent obesity including psychosocial effects (Dietz, 1998; Must & Strauss, 1999), increased risk for cardiovascular disease, type 2 diabetes (Brosnan, Upchurch, & Schreiner, 2001), metabolic syndrome (Alberti, Zimmet, & Shaw, 2006) and persistence of obesity into adulthood (Freedman et al., 2005; Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Guo, Wu, Chumlea, & Roche, 2002;

Serdula et al., 1993; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Further, obesity places an enormous burden on health care systems (Hampl, Carroll, Simon, & Sharma, 2007; Katzmarzyk & Janssen, 2004). Due to the significant long-term health and economic implications of adolescent obesity, research in the area of obesity determinants (such as nutritional intake and physical activity) has become increasingly important and will provide key information for the development of programs to improve the health and well-being of the adolescent population.

Because adolescents are at a life stage where they have increased autonomy regarding health behaviours, many of the decisions and choices adolescents make may persist into adulthood and have lasting impact on long term health (Dietz, 1998). Therefore, the purpose of this study was to assess the overall diet quality of a sample of Alberta adolescents, and evaluate the associations between diet quality, nutrient intakes, meal behaviours and physical activity levels.

6.3 Methods

6.3.1 Participants

The Web-Survey of Physical Activity and Nutrition (Web-SPAN) was a self-administered web-based survey of grade 7 through 10 students (11 to 17 years) that assessed nutrition, physical activity and related meal behaviours. All 59 public and separate (Catholic) school boards in the province of Alberta, Canada were selected for participation. This was done to maximize school recruitment and reduce the impact of cluster randomization caused by the lack of variability between students within school boards and schools and also allowed for participation of schools in both rural and urban areas, public schools, Catholic schools, and private schools which helped to improve the representativeness of the sample. Forty-eight school boards agreed to participate (81%), and an average of seven schools within each school board were randomly chosen and contacted after obtaining school board approval. In addition, private schools were randomly selected based on regional diversity.

School boards and schools were individually contacted by mail (detailed information package) (**Appendix H1, H2, H3, H4**) and follow-up phone calls were made to request permission to survey grade 7 through 10 students. Teachers within participating schools were selected by school administration to faciliate the web-survey, and were subsequently mailed an information package (**Appendix H5**) which included parent and student information letters (**Appendix H6, H7, H8**) and consent forms (**Appendix H9**). After completed consent forms were returned to the research staff by mail, a classroom was eligible to participate in the research study. Logins and passwords were then provided to the teacher for each student with parent permission to participate. Teachers randomly distributed the logins and passwords to participating students on the day of the survey. Students accessed the website using their unique login and password in order to ensure that unauthorized users did not have access to the survey. All students provided assent after signing on to the web-based survey (**Appendix H10**).

The anonymous 24 page survey took approximately 45 minutes to complete and was conducted during class time within the school day. Survey data were collected between January and November 2005 (except in July and August when schools were closed for summer), and thus nutritional intakes may have been affected by seasonal variation.

This research was approved by the University of Alberta Human Research Ethics Board in the Faculty of Agriculture, Forestry, and Home Economics (**Appendix I**), the Cooperative Activities Program in the Faculty of Education at the University of Alberta, and by each participating school board and school.

6.3.2 Procedures

6.3.2.1 Dietary Intake

As part of Web-SPAN, a 24-hour dietary recall was administered to students to measure week day dietary intake using the web-based *Food Behaviour Questionnaire* developed at the University of Waterloo (Hanning, Jessup, Lambraki, MacDonald, & McCargar, 2003) and modified by researchers at the University of Alberta in order to assess variables of interest including meal behaviours, self-efficacy and physical activity. Responding to the electronic survey questions, students reported all foods and beverages consumed during the previous day by selecting items from a list of approximately 500 foods. In addition, a portion of the sample (n = 580; 11.8%) completed repeat 24-hour dietary recalls using Web-SPAN which were used in the micronutrient and fibre analyses in order to assess usual intake with the Software for Intake Distribution (PC-SIDE) developed by Nusser et al. (1996). To help students recall their intake, portion size images and cues regarding beverage intake were provided. Students were able to add or delete items at any time throughout the 24-hour recall using the virtual meal plate and meal summary features.

The 24-hour dietary recall component of the *Food Behaviour Questionnaire* has been validated using several methods. In comparison to a dietitian-administered 24-hour dietary recall, the *Food Behaviour Questionnaire* showed good agreement (intraclass correlation coefficients (ICC); Pearson ρ) for total caloric intake (ICC = 0.66; ρ = 0.70), carbohydrates (ICC = 0.65; ρ = 0.66), protein (ICC = 0.51; ρ = 0.55), fat (ICC = 0.66; ρ = 0.71), fibre (ICC = 0.68; ρ = 0.69) and key micronutrients (ICC = 0.47 to 0.78; ρ = 0.51 to 0.83) when assessed over the same 24-hour period in grade 6 to 8 students (n = 51) (Hanning & Health Behaviour Research Group, 2004). In comparison to direct observation of food items selected at lunch hour versus those selected on the web-survey, grade 9 and 10 students (n = 15) showed an overall agreement of 87% (Hanning et al., 2004).

In addition, repeat comparisons for the web-based 24-hour dietary recall completed an average of 7.8 days apart on a subset of the sample showed overall good agreements where ICC values ranged from 0.45 to 0.64 (macronutrients) and 0.37 to 0.62 (key micronutrients); and Pearson r values ranged from 0.45 to 0.64 (macronutrients) and 0.38 to 0.62 (key micronutrients) (n = 379). When compared to a 3-day food record, the *Food Behaviour Questionnaire* revealed overall agreements where ICC values ranged from 0.26 to 0.35 for macronutrients, and from 0.16 to 0.34 for key micronutrients. Pearson r values ranged from 0.28 to 0.37 for macronutrients and 0.17 to 0.36 for key micronutrients (n = 369) (Chapter 5, p. 145-147).

A measure of diet quality was used to classify students into groups of poor, average or superior diet quality using a food-based diet quality index (Lowik, Hulshof, & Brussaard, 1999), as recommended by Patricia et al. (2007) and modified to reflect CFGHE (Health Canada, 1992) foods. Individuals consume food groups, and not individual nutrients, therefore food-based diet quality indices provide information that can easily be used for health promotion purposes. Further, food based diet quality indices have been validated using the Mean Adequacy Ratio (MAR), a measure of nutrient adequacy (Shatenstein, Nadon, & Ferland, 2003). In the current study, servings of each of the four food groups according to CFGHE (Health Canada, 1992) were calculated using data from the 24-hour dietary recall. Foods that were not classified as Grain Products, Vegetables and Fruit, Milk Products or Meat and Alternatives were categorized as Other Foods and further divided into sub-categories which included foods containing mostly sugar (e.g., candies), high salt/fat foods (e.g., potato chips), high calorie beverages (e.g., regular soft drinks), low calorie beverages (e.g., low calorie soft drinks), or high sugar/fat foods (e.g., pastries) based on Canadian Nutrient File definitions (Health Canada, 2001). Diet quality was defined using the number of minimum food group recommendations that were met based on CFGHE. Individuals were classified as having either poor (met 0-1 food group recommendation), average (met 2-3 food group recommendations), or superior (met all 4 food group recommendations) diet quality. Although not validated, the food groupings were supported by graded responses in key nutrient intakes in each group, where improvements in nutrient intakes were observed when diet quality increased from poor to average to superior (Chapter 4). Canada's Food Guide to Healthy Eating was recently revised and the new food guide, Eating Well with Canada's Food Guide (Health Canada, 2007), was released in early 2007. In spite of this, the 1992 CFGHE was the government recommendation during data collection and was also a component of Alberta school curriculum (Alberta Learning, 2002, 2005). Therefore, it was most appropriate to compare intakes to the 1992 CFGHE recommendations.

Macronutrient and micronutrient intakes were assessed using ESHA Food Processor version 7.9 (ESHA Research, 1987 - 2002) and the 2001b Canadian Nutrient File (Health Canada, 2001) database and compared to the either the Acceptable Macronutrient Distribution Ranges (AMDRs; carbohydrate, protein, fat), the Estimated Average Requirement (EAR; vitamin A, vitamin C, iron, niacin, zinc) or the Adequate Intake (AI; calcium, vitamin D, fibre) which are all components of the Dietary Reference Intakes (DRIs) (Institute of Medicine, 1997, 1998, 2000a, 2000b, 2005). Acceptable Macronutrient Distribution Range recommendations have been established at 45 – 65% of total energy from carbohydrate, 10 – 30% of energy from protein, and 25 – 35% of energy from fat (Institute of Medicine, 2005). Micronutrient and fibre intakes were compared to either the EAR, which is an estimate of intake needed to meet the requirement of half the healthy individuals in a particular life stage and gender group (Institute of Medicine, 2000c); or the AI, which is the recommended intake that is assumed to be adequate in healthy individuals and only developed in situations where an EAR cannot be determined (Institute of Medicine, 2000c). Estimates of inadequacy were calculated for nutrients with an EAR. However, inadequacy was not determined for nutrients with an AI, as many values below the AI are likely to be adequate (Institute of Medicine, 2000c). Dietary Reference Intakes and CFGHE requirements are presented in **Tables 6.1** and **6.2.**

6.3.2.2 Sub-Optimal Meal Behaviours

Sub-optimal meal behaviours (meal skipping and consuming meals away from home) were assessed using data from 12 survey questions involving frequency of meal consumption and frequency of consuming meals away from home. Survey questions examining sub-optimal meal behaviours are comparable to questions developed for Project EAT (Eating Among Teens), a well-established survey instrument (Neumark-Sztainer, Story, Hannan, Perry, & Irving, 2002; Neumark-Sztainer, Wall, Story, & Perry, 2003). Frequency of meal consumption was assessed by asking "How often do you usually eat?" followed by "breakfast", "lunch", "dinner", "morning snacks", afternoon snacks", or "evening snacks". Participants selected from the following response options: "Never", "On weekends only", "Less than half of the week (three or fewer days each week)", "More than half of the week (four or more days each week)", "Every day", and "Not answered". Each response was assigned a score between 1 and 5 ("never" = 1, "every day" = 5), with higher scores representing a greater frequency of consuming each meal. Frequency of consuming meals away from home was assessed by asking "How often do you eat meals or snacks prepared away from home?", with response options of "rarely or never", "once a month", "once a week", "2-6 times a week", and "once a day". Each response was assigned a score between 1 and 5 ("rarely or never" = 1, "once a day" = 5), with higher scores representing a greater frequency of consuming meals away from home. The following locations were assessed: school cafeteria, fast food restaurant or take out, other restaurants, vending machines, snack bars (e.g., the canteen at an arena), and convenience stores.

6.3.2.3 Physical Activity

A web-based version of the Physical Activity Questionnaire for Older Children (PAQ-C) was used to assess physical activity levels over a seven-day period. The PAQ-

C was specifically designed for Canadian school-aged youth, and includes components of physical activity during the school day as well as after school and weekend activity (Kowalski, Crocker, & Donen, 2004). The questionnaire consists of 10 items, of which 9 are used to calculate an activity score. Responses are converted to a 5-point scale where a higher score represents greater levels of physical activity (scores range from 1.00 to 5.00). The PAQ-C was found to be a reliable method to assess physical activity when test-retest reliability was examined over a period of one week in 84 boys (r = 0.75) and girls (r = 0.82) ages 9 to 14 years (Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997). Furthermore, the PAQ-C was found to be a valid measure in 9 to 14 year olds (n = 97) when compared to other physical activity assessment methods including an activity rating (r = 0.57), the Leisure Time Exercise Questionnaire (r = 0.41), a 7-day physical activity recall interview (r = 0.46), a Caltrac motion sensor (r = 0.39), and a Canadian Home Fitness Test (step test) of fitness (r = 0.28) (Kowalski, Crocker, & Faulkner, 1997). In addition, test-retest reliability for the web-based PAQ-C completed an average of 7.8 days apart on a subset of the sample, showed good agreements of 0.79 (ICC) and 0.79 (Pearson r) (n = 323). Further, when compared to the guided self-administered paper-based PAQ-C, the web-based PAQ-C showed good agreement (ICC = 0.70; Pearson r = 0.70) (n = 411) (Chapter 5, p. 147-148).

Although the Physical Activity Questionnaire for Adolescents (PAQ-A) was developed specifically for use in the adolescent population, many rural Alberta schools still have daily recess. Therefore, students were given the option of selecting the answer that "they do not have recess" instead of using the PAQ-A which omits the activity at recess question from the PAQ-C.

6.3.2.4 Statistical Analyses

Macronutrient intakes (carbohydrate, protein, and fat), food group intakes, physical activity levels and differences in intake and physical activity levels between gender and age were analyzed using descriptive statistics, chi-squared tests, t-tests, and Mann-Whitney U tests. Analysis of variance (ANOVA) was used to assess the difference in physical activity levels between those with poor, average and superior diet quality. In order to assess the prevalence of micronutrient inadequacy, multiple days of intake data were used to adjust for intra-individual variation. Nutrient intake distributions are non-normal, and therefore the prevalence of inadequacy cannot be accurately determined using a one-day measure. It is known that food intake varies between individuals as well as within individuals, therefore it is necessary to separate the inter-individual from intra-individual variation which can be done when multiple days of intake data are available (Barr, 2006). The PC-SIDE software (Nusser et al., 1996) was used to adjust for intra-individual variation producing estimates of usual intake and prevalence of micronutrient inadequacy as expressed as the percent below the EAR.

A 2 X 3 multivariate analyses of co-variance (MANCOVA), with total caloric intake as the covariate was used to evaluate the association between gender (boys, girls) and diet quality (poor, average, superior). Univariate follow-ups were completed on significant MANCOVA results for dependent variables which included nutrient intakes (carbohydrate, protein, fat, fibre), servings of Other Foods (mostly sugar, high salt/fat, high calorie beverages, low calorie beverages, high sugar/fat), frequency of meal consumption (breakfast, lunch, dinner; mean of morning, afternoon, and evening snacks), and frequency of consuming meals away from home (school cafeteria, fast food restaurant or take out, other restaurants, vending machines, snack bars, convenience stores). Prior to the MANCOVA analyses, the assumption of homogenous slopes (D'Alonzo, 2004; Tabachnick & Fidell, 2007) was tested, and interactions indicated that the slopes differed among levels of the independent variables. Therefore, adjusted values were based on custom models which included these interactions for the following MANCOVA analyses: macronutrients, Other Foods, and frequency of meal consumption.

Statistical analyses were performed using the software program SPSS (version 15.0; SPSS Inc, Chicago). A criterion α-level of $p < 0.05$ was used for all statistical comparisons.

6.4 Results

6.4.1 Demographics

Initially, 4981 adolescents agreed to participate in the study. Participating students that signed on to the website but did not complete the survey ($n = 9$), and students with extreme values of total caloric intake or physical activity levels based on outlier analyses (non-mutually exclusive outliers: total caloric intake, $n = 24$; physical activity, $n = 14$; total outliers removed, $n = 36$) were excluded. Thus, a final sample of 4936 adolescents was included in the analyses (boys = 2264; girls = 2623; mean age = 13.6 years). The greater percentage of participating girls, suggests differential recruitment, such that girls were more likely to participate than boys. During data collection, students were free to end the survey at any time, and were not required to answer every question in order to participate. Therefore, sample size varies throughout the analyses. In total 21 students did not complete the 24-hour dietary recall, while 521 students did not complete the physical activity questionnaire. In addition, 49 students did not indicate their gender, which influenced sample size when differences between genders were assessed. In total, 363 schools were contacted of which 193 (53%) agreed to participate, 160 (44%) declined participation, and 10 (3%) were ineligible based on inappropriate grade levels. Upon completion of the study, final participation was 136 schools within 44 school boards, representing a 37% response rate at the school level and a 75% response rate at the school board level. This represents a convenience sample of Alberta students. Reasons for refusal were generally due to time constraints throughout the school year.

6.4.2 Nutrient Intakes

Results of the 24-hour recall data revealed that, on average, distribution of energy from carbohydrate, protein and fat were within the AMDRs for both boys (53.4% carbohydrate, 15.8% protein and 32.2% fat) and girls (55.8% carbohydrate, 14.9% protein, 31.0% fat). Boys consumed significantly more total energy (kcals/day) (boys = 2398 ± 1204 kcals/day; girls = 1801 ± 913 kcals/day) ($t = 19.27$, $p < 0.001$), protein (as a percent of energy: % kcal) (boys = 15.8 ± 5.4%; girls = 14.9 ± 5.2%) ($t = 5.7$, $p < 0.001$), and fat (% kcal) (boys = 32.2 ± 9.1%; girls = 31.0 ± 9.2%) ($t = 4.5$, $p < 0.001$) than girls; while girls consumed significantly more carbohydrate (% kcal) (boys = 53.4 ± 11.4%; girls = 55.8 ±11.2%) ($t = -7.3$, $p < 0.001$) than boys.

Adjusted average nutrient intakes and prevalence of micronutrient inadequacy are presented in **Table 6.1** for vitamin A, vitamin C, iron, niacin, zinc, calcium, vitamin D, and fibre. Adequate consumption of these nutrients is considered essential for optimal nutrition; these nutrients are generally found in high amounts in foods represented in the four food groups. Results are presented by life stage and gender group according to the Institute of Medicine for the DRIs (Institute of Medicine, 2000c).

Table 6.1: Dietary Reference Intakes (DRIs) (Institute of Medicine, 1997, 1998, 2000a, 2000b, 2005) and Adjusted Average Intakes Compared to Recommendations Among Adolescents Aged 11 to 17 Years[*]

Nutrient	DRI Value (DRI Category)[†]	Adjusted Average Intake[‡]	Percent below the EAR[§]
Vitamin A (µg)[**]			
Boys 9 – 13	445 (EAR)	22.0	
Boys 14 – 17	630 (EAR)	23.9	
Girls 9 – 13	420 (EAR)	23.7	
Girls 14 – 17	485 (EAR)	22.9	
Vitamin C (mg)			
Boys 9 – 13	39 (EAR)	133.4	6.4
Boys 14 – 17	63 (EAR)	137.3	18.2
Girls 9 – 13	39 (EAR)	134.6	6.7
Girls 14 – 17	56 (EAR)	126.0	12.1
Iron (mg)			
Boys 9 – 13	5.9 (EAR)	14.1	2.6
Boys 14 – 17	7.7 (EAR)	16.1	3.9
Girls 9 – 13	5.7 (EAR)	10.6	6.4
Girls 14 – 17	7.9 (EAR)	10.5	21.5
Niacin (mg)			
Boys 9 – 13	9 (EAR)	19.4	4.0
Boys 14 – 17	12 (EAR)	20.8	10.2
Girls 9 – 13	9 (EAR)	14.7	13.2
Girls 14 – 17	11 (EAR)	14.7	21.2
Zinc (mg)			
Boys 9 – 13	7 (EAR)	10.9	20.3
Boys 14 – 17	8.5 (EAR)	11.9	19.6
Girls 9 – 13	7 (EAR)	8.1	37.7
Girls 14 – 17	7.3 (EAR)	7.7	49.2
Calcium (mg)			
Boys 9 – 13	1,300 (AI)	1132.9	
Boys 14 – 17	1,300 (AI)	1197.5	
Girls 9 – 13	1,300 (AI)	945.6	
Girls 14 – 17	1,300 (AI)	910.1	
Vitamin D (µg)			
Boys 9 – 13	5 (AI)	5.7	
Boys 14 – 17	5 (AI)	5.7	
Girls 9 – 13	5 (AI)	4.4	
Girls 14 – 17	5 (AI)	4.2	
Fibre (g)			
Boys 9 – 13	31 (AI)	15.3	
Boys 14 – 17	38 (AI)	16.4	
Girls 9 – 13	26 (AI)	13.6	
Girls 14 – 17	26 (AI)	13.1	

[*] Four students were younger than age 11 due to mixed grade level classrooms
[†] EAR = Estimated Average Requirement, AI = Adequate Intake
[‡] Adjusted for intra-individual variation of intake using the Software for Intake Distribution Estimation (PC-SIDE)
[§] Calculated only for nutrients with an EAR as recommended by the Institute of Medicine (Institute of Medicine, 2000c).
[**] An estimate of inadequacy (percent below the EAR) could not be determined for vitamin A due to high frequencies of individual intakes at 0 µg.
Abbreviations: µg (micrograms), mg (milligrams), g (grams)

Canada's Food Guide to Healthy Eating data are presented in **Table 6.2** as median food group intakes and interquartile ranges with comparisons based on gender. Significant differences were observed between boys and girls for all food groups; boys consumed significantly higher intakes of Grain Products, Vegetables and Fruit, Meat and Alternatives, Milk Products, and Other Foods (**Table 6.2**). Compared to CFGHE, boys' median intakes of Grain Products and Meat and Alternatives met or exceeded the minimum recommendations, while girls' median intakes were below minimum recommendations for all four food groups. Additionally, boys were more likely than girls to meet CFGHE recommendations for all four food groups (Grain Products (χ^2 (1) = 145.97, $p < 0.001$); Vegetables and Fruit (χ^2 (1) = 11.11, $p = 0.001$); Meat and Alternatives (χ^2 (1) = 143.77, $p < 0.001$); Milk Products (χ^2 (1) = 86.18, $p < 0.001$) (n = 4867). Among boys, 56% met the CFGHE recommendation for Grain Products, 44% for Vegetables and Fruit, 66% for Meat and Alternatives and 41% for Milk Products. In comparison, only 39% of girls met the CFGHE recommendation for Grain Products, 39% for Vegetables and Fruit, 49% for Meat and Alternatives, and 28% for Milk Products.

Table 6.2: Canada's Food Guide to Healthy Eating Recommendations (Health Canada, 1992) and 25th, 50th and 75th Percentiles of Servings Consumed by Canadian Adolescents Aged 11 to 17 Years[*]

CFGHE Groups (Recommended Daily Servings)	Number of Servings						P Value[†]
	Boys (n = 2252)			Girls (n = 2615)			
	25th	50th	75th	25th	50th	75th	
Grain Products (5 – 12)	3.3	5.6	8.8	2.2	4.0	6.4	< 0.001
Vegetables and Fruit (5 – 10)	2.2	4.4	7.4	2.2	4.1	6.5	0.005
Milk Products (10 to 16 years: 3 – 4)	0.9	2.3	3.9	0.6	1.7	3.1	< 0.001
Meat and Alternatives (2 – 3)	1.5	3.0	5.0	0.8	1.9	3.3	< 0.001
Other Foods (in moderation)	3.0	5.5	9.0	2.4	4.5	7.3	< 0.001

[*]Four students were younger than age 11 due to mixed grade level classrooms

[†]Significance between genders using Mann-Whitney U test

6.4.3 Diet Quality

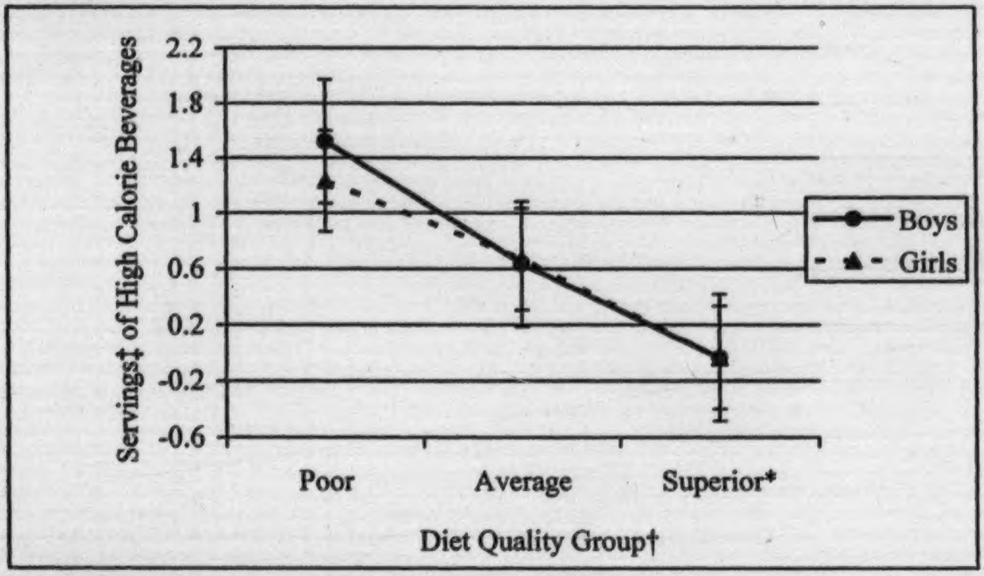
Overall diet quality indicated that 42% (n = 2020) of students had poor diet quality, 50% (n = 2450) had average diet quality and 8% (n = 397) had superior diet quality. Among boys, 32% (n = 721) had poor diet quality, 56% (n = 1263) had average diet quality and 12% (n = 268) had superior diet quality. In comparison, 50% (n = 1299) of girls had poor diet quality, 45% (n = 1187) had average diet quality and 5% (n = 129) had superior diet quality.

6.4.3.1 Diet Quality and Nutrient Intakes

Multivariate F values for both gender (Wilks' Lambda = 1.00, F(4, 4854) = 2.38, p = 0.049) and diet quality (Wilks' Lambda = 0.96, F(8, 9708) = 22.51, p < 0.001) were significant, while the interaction between diet quality and gender was not significant (Wilks' Lambda = 1.00, F(8, 9708) = 1.13, p = 0.340). Univariate follow-up analysis for the main effect of gender revealed that boys consumed more protein (F(1, 4857) = 21.40, p < 0.001) and less fat (F(1, 4857) = 4.08, p = 0.043) and fibre (F(1, 4857) = 10.91, p = 0.001) than girls. The univariate F values for the main effect of diet quality indicated that those with poor diet quality had significantly lower intakes of protein and fibre, and significantly higher intakes of carbohydrates and fat compared to both those with average diet quality as well as those with superior diet quality. Further, significant differences existed between those with average and those with superior diet quality for protein, fat, and fibre. **Table 6.3** provides data on the micronutrient intakes grouped by diet quality.

The association between diet quality and gender with Other Foods sub-categories as assessed using a MANCOVA revealed significant F values for gender (Wilks' Lambda = 1.00, F(5, 4853) = 4.79, p < 0.001) and diet quality (Wilks' Lambda = 0.99, F(10, 9706) = 6.45, p < 0.001) and the interaction between diet quality and gender (Wilks' Lambda = 1.00, F(10, 9706) = 2.45, p = 0.006). Interactions indicated that boys in the poor diet quality group consumed more high calorie beverages than girls in the same group (**Figure 6.1**). Boys consumed less low calorie beverages (F(1, 4857) = 15.17, p < 0.001) than girls. Univariate analyses for the main effect of diet quality showed significant F values for all Other Food sub-categories. Those with poor diet quality had significantly higher intakes of foods containing mostly sugar, high salt/fat foods, high calorie beverages, and high sugar/fat foods compared to both those with average diet quality as well as those with superior diet quality. Individuals with poor diet quality had significantly lower intakes of low calorie beverages compared to both those with average and superior diet quality. Significant differences also existed between those with average and superior diet quality. The results of Other Foods sub-categories comparisons by diet quality are presented in **Table 6.3**.

Figure 6.1: Interaction between Diet Quality and Gender: Intake of High Calorie Beverages



*Significant interactions at $p < 0.05$

†Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations

‡Adjusted for total caloric intake (energy)

Table 6.3: Group Differences in Adjusted[*] Nutrient Intakes Based on Diet Quality[†]

	Diet Quality[‡]			F Value	P Value
	Poor	Average	Superior		
Nutrients (g) (n = 4867)					
Carbohydrate	$287.45 \pm 1.82^{\S,a}$	274.86 ± 1.15^{b}	$275.48 \pm 4.43^{b,c}$	17.26	$< 0.001^{ab}$; 0.012^{ac}
Protein	67.66 ± 0.82^{a}	84.04 ± 0.52^{b}	96.07 ± 1.98^{c}	177.94	$< 0.001^{ab, ac, bc}$
Fat	76.58 ± 0.66^{a}	74.84 ± 0.42^{b}	69.68 ± 1.61^{c}	8.38	0.027^{ab}; $< 0.001^{ac}$; 0.002^{bc}
Fibre	13.71 ± 0.24^{a}	15.00 ± 0.15^{b}	17.34 ± 0.58^{c}	20.85	$< 0.001^{ab, ac, bc}$
Other Food Groups Sub-categories (servings/day) (n = 4867)					
Mostly Sugar	1.12 ± 0.05^{a}	0.87 ± 0.03^{b}	$0.66 \pm 0.12^{b,c}$	11.18	$< 0.001^{ab, ac}$
High Salt/Fat	1.12 ± 0.04^{a}	0.43 ± 0.02^{b}	0.03 ± 0.09^{c}	146.38	$< 0.001^{ab, ac, bc}$
High Calorie Beverages	1.38 ± 0.04^{a}	0.65 ± 0.03^{b}	-0.03 ± 0.11^{c}	133.48	$< 0.001^{ab, ac, bc}$
Low Calorie Beverages	1.11 ± 0.06^{a}	1.28 ± 0.04^{b}	1.81 ± 0.16^{c}	9.00	0.030^{ab}; $< 0.001^{ac}$: 0.001^{bc}
High Sugar/Fat	0.74 ± 0.03^{a}	0.59 ± 0.02^{b}	$0.46 \pm 0.08^{b,c}$	9.94	$< 0.001^{ab}$; 0.001^{ac}

[*] Adjusted for total caloric intake (energy)

[†] Univariate analyses

[‡] Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations

[§] Mean ± SE (the two decimal places represent statistical requirements, however the accuracy of the instrument is appropriate to the level of whole numbers only)

[a,b,c] Different superscript letters in each row indicate significant statistical differences

Abbreviations: g (grams), SE (standard error of the mean)

6.4.3.2 Diet Quality and Sub-Optimal Meal Behaviours

Multivariate analysis of covariance used to assess meal frequency yielded significant main effects for gender (Wilks' Lambda = 1.00, F(4, 3705) = 3.75, p = 0.005) and diet quality (Wilks' Lambda = 0.98, F(8, 7410) = 9.30, $p < 0.001$), but not for the interaction between diet quality and gender (Wilks' Lambda = 1.00, F(8, 7410) = 1.29, p = 0.242). Boys had higher frequencies of consuming breakfast (F(1, 3708) = 4.71, p = 0.030) and lunch (F(1, 3708) = 4.15, p = 0.042) than girls. Results of the univariate analysis comparing those with poor, average and superior diet quality in terms of meal frequency are presented in **Table 6.4**. Follow-up univariate analyses revealed that those with poor diet quality had a significantly lower frequency of consuming breakfast compared to both those with average diet quality as well as those with superior diet quality. Further, significance was observed for breakfast consumption between those with average and superior diet quality. No differences were observed for lunch, dinner and snack consumption.

The association between diet quality and gender with frequency of consuming meals away from home as assessed using a MANCOVA revealed significant F values for gender (Wilks' Lambda = 0.98, F(6, 4193) = 11.45, $p < 0.001$) and diet quality (Wilks' Lambda = 0.98, F(12, 8386) = 5.82, $p < 0.001$) but not for an interaction between diet quality and gender (Wilks' Lambda = 1.00, F(12, 8386) = 0.77, p = 0.687). Univariate analyses revealed that boys had higher frequencies of consuming meals away from home than girls at all locations including school cafeterias (F(1, 4198) = 7.36, p = 0.007), fast food or take out (F(1, 4198) = 27.05, $p < 0.001$), other restaurants (F(1, 4198) = 27.93, $p < 0.001$), vending machines (F(1, 4198) = 45.51, $p < 0.001$), snack bars (F(1, 4198) =

31.23, p < 0.001), and convenience stores (F(1, 4198) = 36.36, p < 0.001). **Table 6.4** provides data on differences in frequencies of consuming meals away from home between those with poor, average and superior diet quality. Follow-up univariate analyses revealed significant group differences between those with poor, average and superior diet quality regarding the frequency of consuming meals or snacks from the following locations: school cafeteria, fast food or take out, other restaurants, vending machines, snack bars, and convenience stores. Those with poor diet quality consumed significantly more meals or snacks away from home at all locations compared to both those with average diet quality as well as those with superior diet quality. Significance between average and superior diet quality groups was observed at all locations, with the exception of the school cafeteria (**Table 6.4**).

Table 6.4: Group Differences in Sub-Optimal Meal Behaviours[*] Based on Diet Quality[†]

	Diet Quality[‡]			F Value	P Value
	Poor	Average	Superior		
Meal Frequency[§] (n = 3718)					
Breakfast	4.20 ± 0.04^{§,a}	4.34 ± 0.03^{b}	4.69 ± 0.13^{c}	8.46	0.007^{ab}; < 0.001^{ac}; 0.006^{bc}
Lunch	4.66 ± 0.03	4.69 ± 0.02	4.86 ± 0.08	2.78	nsd
Dinner	4.90 ± 0.02	4.88 ± 0.01	4.94 ± 0.05	0.80	nsd
Snacks	3.52 ± 0.04	3.46 ± 0.03	3.37 ± 0.11	1.41	nsd
Consuming Meals and Snacks Away From Home[††] (n = 4205)					
School Cafeteria	2.43 ± 0.04^{a}	2.26 ± 0.03^{b}	2.21 ± 0.09^{b,c}	4.96	0.002^{ab}; 0.042^{ac}
Fast Food/Take Out	2.37 ± 0.03^{a}	2.25 ± 0.02^{b}	2.08 ± 0.06^{c}	10.18	0.001^{ab}; < 0.001^{ac}; 0.004^{bc}
Other Restaurants	2.10 ± 0.02^{a}	2.02 ± 0.02^{b}	1.91 ± 0.05^{c}	5.31	0.010^{ab}; 0.002^{ac}; 0.048^{bc}
Vending Machines	2.31 ± 0.03^{a}	2.08 ± 0.03^{b}	1.83 ± 0.07^{c}	19.20	< 0.001$^{ab,\ ac}$; 0.001^{bc}
Snack Bars	2.33 ± 0.03^{a}	2.15 ± 0.03^{b}	1.93 ± 0.07^{c}	12.91	< 0.001$^{ab,\ ac}$; 0.002^{bc}
Convenience Stores	2.66 ± 0.03^{a}	2.42 ± 0.02^{b}	2.11 ± 0.07^{c}	26.55	< 0.001$^{ab,\ ac,\ bc}$

[*] Adjusted for total caloric intake (energy)

[†] Univariate analyses

[‡] Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations

[§] Meal Frequency: never = 1, on weekends only = 2, less than half of the week (three or fewer days each week) = 3, more than half of the week (four or more days each week) = 4, every day = 5; Snacks were averaged before analysis (morning snacks, afternoon snacks, evening snacks)

[**] Mean ± SE

[††] Consuming Meals and Snacks Away From Home: rarely or never = 1, once a month = 2, once a week = 3, 2-6 times a week = 4, once a day = 5

[a,b,c] Different superscript letters in each row indicate significant statistical differences

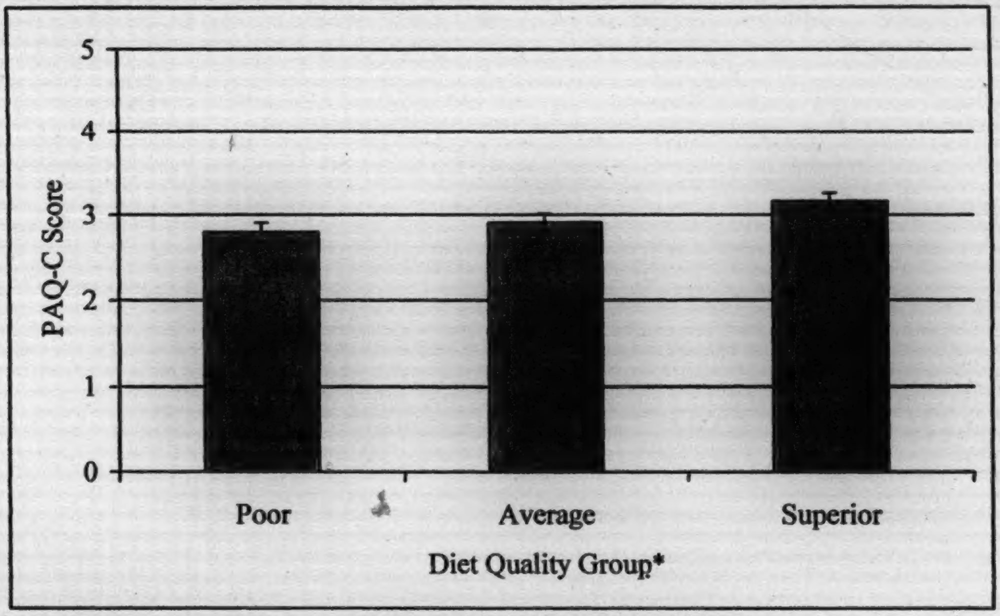
Abbreviations: SE (standard error of the mean), nsd (no significant difference)

6.4.4 Physical Activity

Results indicated that more than half of students (57%) had physical activity levels below a score of three (moderate activity), with average physical activity levels at 2.88 ± 0.68. Boys had significantly higher physical activity levels than girls (boys = 2.99 ± 0.71; girls = 2.79 ± 0.63) ($t = 9.76$, $p < 0.001$), and younger students (13 or less years) had significantly higher physical activity levels than older students (14 years or older) (younger = 2.97 ± 0.66; older = 2.81 ± 0.68) ($t = 7.81$, $p < 0.001$).

Significant differences were observed in physical activity levels between those with poor, average and superior diet quality ($F(2, 4391) = 47.80$, $p < 0.001$) based on ANOVA. Students with poor diet quality (2.80 ± 0.02 (std. error)) had significantly lower levels of physical activity compared to those with both average (2.91 ± 0.01, $p < 0.001$) and superior diet quality (3.16 ± 0.04, $p < 0.001$). Further, students with average diet quality had significantly lower levels of physical activity compared to their peers with superior diet quality ($p < 0.001$) (**Figure 6.2**).

Figure 6.2: Group Differences in Physical Activity Levels[†] Based on Diet Quality[‡]



[†]Assessed using the PAQ-C (maximum score of 5.00) (ANOVA)
[‡]Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations
[*]Significant between all three diet quality groups at $p < 0.001$
Abbreviation: PAQ-C (Physical Activity Questionnaire for Older Children)

6.5 Discussion

The purpose of this study was to use Web-SPAN to assess the overall diet quality of a sample of Alberta adolescents, and evaluate the relationship between diet quality, nutrient intakes, meal behaviours, and physical activity levels. Although numerous studies have examined the nutrition and physical activity status of adolescents, few have used a measure of food-based total diet quality to examine the associations between nutrient intakes, meal behaviours and physical activity. Further, many Canadian studies that measured diet quality were completed in children (Glanville & McIntyre, 2006), adults (Glanville & McIntyre, 2006) or older adults (Shatenstein, Nadon, Godin, &

Ferland, 2005), and used a measure of diet quality based on the Healthy Eating Index, a measure of diet quality developed specifically for the U.S. population.

We found that a high proportion of adolescents had poor diet quality (42%), based on low intakes of foods in CFGHE. Further, students with poor diet quality were more likely to have sub-optimal nutritional intakes, meal behaviours, and low levels of physical activity.

6.5.1 Nutrient Intakes

Macronutrient, micronutrient, and CFGHE servings were assessed using data from the 24-hour recall component of Web-SPAN. In comparison to recommendations established by the Institute of Medicine for macronutrients, both boys' and girls' intakes were consistent with previous reports (Garriguet, 2004) and were within the AMDRs for carbohydrate, protein and fat which have been established at 45 – 65%, 10 – 30%, and 25 – 35% respectively. Although observed mean intakes were within the AMDR for all macronutrients, over one-third of boys (38.9%) and girls (33.5%) were above the recommendation for percent energy from fat. Given the association between dietary fat intake and chronic disease (Institute of Medicine, 2005) and evidence that suggests atherosclerosis begins in childhood (Burke, 2006), these results indicate that many adolescents with sub-optimal macronutrient distributions could suffer from adverse health consequences in the future.

Consistent with results from previous studies (Gray-Donald, Jacobs-Starkey, & Johnson-Down, 2000; Veugelers, Fitzgerald, & Johnston, 2005), micronutrient intakes for zinc, calcium and fibre were low in this sample of adolescents based on a high percentage of students below the EAR (zinc), or adjusted average intakes below the AI (calcium, fibre). Older boys and girls (14 – 17 years) had a greater risk of inadequacy compared to younger boys and girls (9 – 13 years) for most nutrients. This indicates that although micronutrient requirements increase with age, older adolescents had similar intakes to their younger peers and were not consuming optimal nutritional intakes for their physiological requirements. While intakes of vitamin A appeared low, this was likely due to the extreme variation in daily intake of this nutrient (Institute of Medicine, 2000a).

Zinc deficiency is uncommon in North America as it is widely found in animal products (Institute of Medicine, 2000a); however, low intakes of Meats and Alternatives and Milk Products (categories of CFGHE) were likely the cause of the observed high prevalence of inadequacy. Dietary Reference Intakes for calcium were established to promote optimal levels of calcium retention in order to support growth and prevent osteoporosis (Institute of Medicine, 1997). The recommendation for fibre was established to reduce the risk of coronary heart disease, diet-related cancer, obesity and type 2 diabetes (Institute of Medicine, 2005). Adequate consumption of micronutrients is necessary for prevention of deficiency and reduction of chronic disease. Given the low levels of zinc, calcium and fibre observed in this sample of adolescents, many students had sub-optimal nutritional intakes that, in turn, could have an effect on long-term health and prevention of disease.

Intakes of foods found in CFGHE were low for both boys and girls. Although boys were more likely to meet CFGHE recommendations for all four food groups than girls, less than 50% of boys met the recommendations for Vegetables and Fruit and Milk

Products. Among girls, intakes were even poorer with less than 50% meeting the recommendations for all food groups. These results are consistent with the micronutrient analyses, where inadequate consumption of zinc, calcium and fibre correspond to low intakes of Meats and Alternatives, Milk Products, and Grain Products and Vegetables and Fruits, respectively. Given the observed high intakes of Other Foods, it is likely that students were compensating for low CFGHE intakes with Other Foods, which concurrently resulted in low micronutrient intakes. Data from the 2004 CCHS supports this finding; results indicated that the second largest contributor of total kilocalories in the diet of adolescents was from Other Foods, at 22% of total kilocalories (Garriguet, 2004). Furthermore, a study by Jacobs Starkey (2001) found that the Other Foods category provided more than 25% of energy, making Other Foods the most predominant source of kilocalories.

6.5.2 Diet Quality

Overall adherence to CFGHE was low; only 8% of students had superior diet quality (met all 4 food group recommendations), compared to 50% with average diet quality (met 2-3 food group recommendations), and 42% with poor diet quality (met 0-1 food group recommendations). Although each food group is individually important, total health and wellness relies on the appropriate balance and variety of all food groups (Health Canada, 1992). In this study, diet quality was assessed using the minimum recommendations met established by CFGHE. The low percentage of students meeting the criteria for superior diet quality reflects the high prevalence of micronutrient inadequacy, and supports the need for improved adherence to CFGHE.

6.5.2.1 Diet Quality and Nutrient Intakes

Results indicated that those with poor diet quality had lower intakes of protein, fibre and low calorie beverages, and higher intakes of carbohydrates, fat, foods containing mostly sugar, high salt/fat foods, high calorie beverages and high sugar/fat foods compared to both those with average diet quality as well as those with superior diet quality. Further, significant differences existed between those with average and superior diet quality for protein, fat, fibre, high salt/fat foods and high calorie beverages, which revealed a step-wise improvement in nutrition when diet quality increased from poor to average to superior. Thus students appear to be compensating for low intakes of nutrient-rich CFGHE foods by consuming Other Foods not found in CFGHE, and it appears that adherence to CFGHE would result in higher intakes of fibre, and lower intakes of fat and Other Foods. In addition, it should be noted that adherence to CFGHE may not be sufficient in order to meet the DRI for fibre. Although average fibre intakes of those with superior diet quality were significantly higher than those with either poor or average diet quality, intakes were well below the DRI. However, it should be noted that mean differences in nutrient intakes between diet quality groups were small, indicating that although trends were observed, the biological relevance in consuming small, yet significant differences in macronutrients is unclear.

6.5.2.2 Diet Quality and Sub-Optimal Meal Behaviours

Breakfast skipping is highly prevalent in the adolescent population, and is associated with poor nutritional behaviours and increased prevalence of overweight

(Rampersaud, Pereira, Girard, Adams, & Metzl, 2005). Data from the 2004 CCHS revealed that 10% of adolescents reported skipping breakfast the day before they were interviewed (Garriguet, 2004). However, there is less understood regarding the association between diet quality and sub-optimal meal behaviours. In this study, those with poor diet quality had a lower frequency of breakfast consumption compared to both those with average and superior diet quality. This suggests that regular consumption of breakfast is an important determinant of a student's ability to meet CFGHE and DRI recommendations.

As expected, increased frequency of consuming meals or snacks away from home was associated with lower diet quality scores. Fast food consumption has been previously associated with higher percent of energy from fat, daily servings of soft drinks, and lower intakes of fruit, vegetables and milk (French, Story, Neumark-Sztainer, Fulkerson, & Hannan, 2001) and supports the findings of the current study. Although sub-optimal nutritional intakes have been associated with fast food consumption in numerous studies, less is known regarding the consumption of meals at additional locations. Results from the present study indicated that students were more likely to have lower diet quality scores when they consumed meals or snacks at any location away from home. This suggests that sub-optimal nutritional intake is not limited to fast food restaurants, and consumption of meals away from home should be examined more broadly.

6.5.3 Physical Activity

Consistent with previous reports (Canadian Fitness and Lifestyle Research Institute, 2004; Shields, 2005), more than half of students (57%) had physical activity levels below a score of three, representing low to moderate physical activity levels. Further, boys reported significantly higher physical activity levels than girls, and younger students (13 or less years of age) had significantly higher physical activity levels than older students (14 years of age or older). In comparison to a study done by Kowalski et al. (Kowalski et al., 1997), physical activity levels were slightly lower in our study. However, the difference is likely due to the age of the participants in each study, as it is known that physical activity decreases with age (Canadian Fitness and Lifestyle Research Institute, 2004, 2006). In the current study the age range was 11 to 17 years, while students that participated in the study by Kowalski et al. ranged from 8 to 13 years.

Students with poor diet quality had significantly lower levels of physical activity compared to those with both average and superior diet quality. In addition, students with average diet quality had significantly lower levels of physical activity compared to their peers with superior diet quality. Similar to the improved nutrition result, this also suggests a step-wise improvement in physical activity when diet quality increased from poor to average to superior. Thus, students with the highest activity levels also had the highest diet quality scores, which suggests a clustering of positive lifestyle behaviours. Although socioeconomic status (SES) was not measured in the current study, results from a previous web-based survey indicated that vegetable and fruit, fibre and breakfast consumption increased with increasing income, and that consumption of added sugar decreased (Minaker et al., 2006). Further, students attending private schools had a higher consumption of fibre and a lower consumption of sweetened drinks compared to their peers attending public school (Minaker et al., 2006). Similarly, adolescents living in lower-SES neighbourhoods are less physically active and at greater risk of being overweight (Gordon-Larsen, Nelson, Page, & Popkin, 2006; Janssen, Boyce, Simpson, & Pickett, 2006). Thus, the association between diet quality and physical activity observed in the current study may be partially explained by household and neighbourhood SES of the students.

One limitation of the study was the use of self-reported survey data. Although validated survey components were used, many adolescents experience recall bias, response bias, and underreporting of total energy intake (Bandini et al., 2003; Livingstone et al., 1992). In addition, ethnicity and SES were not examined in the current study. However, strengths of this study include anonymity and privacy which are important determinants when adolescents choose to report honest answers (Ginsburg et al., 1995; Supple, Aquilino, & Wright, 1999), decreased reactivity because students were not aware in advance what day the survey was to be completed, and the large sample size.

In summary, our sample of Alberta adolescents met the AMDR recommendations for macronutrients. However, adolescents consumed sub-optimal intakes of micronutrients including zinc, calcium and fibre in addition to low intakes of foods found in CFGHE and high intakes of Other Foods. The high number of students with poor diet quality reflects these intakes, meal skipping and increased meals away from home. Increased consumption of regular meals, including breakfast, and decreased consumption of meals away from home (regardless of the location) may improve adherence to CFGHE, which in turn could result in improved nutritional intakes. In addition, students with high activity levels also had high diet quality scores, which represent a clustering of positive lifestyle behaviours. Further research is necessary to explain reasons for clustering of behaviours. In this sample, it was observed that older adolescents had a higher prevalence of micronutrient inadequacy when compared to their younger peers. Further, improvements in nutrition and physical activity were observed in a step-wise fashion when diet quality increased from poor to average to superior. It is therefore recommended that sub-optimal health behaviours be targeted in early adolescence in order to promote improvements in nutrition and physical activity levels prior to older adolescence. Even small improvements in diet quality and physical activity may result in a greater frequency of optimal health behaviours and could have a lasting impact on long term health.

6.6 References

Alberta Learning. (2002). Health and life skills, kindergarten to grade 9 [Electronic Version]. Retrieved December 7, 2006 from http://www.education.gov.ab.ca/k_12/curriculum/bySubject/healthpls/health.pdf.

Alberta Learning. (2005). Career and technology studies [Electronic Version]. Retrieved December 7, 2006 from http://www.education.gov.ab.ca/k%5F12/curriculum/bySubject/cts/foods/fodpos.pdf.

Alberti, K. G., Zimmet, P., & Shaw, J. (2006). Metabolic syndrome--a new world-wide definition. A Consensus Statement from the International Diabetes Federation. *Diabetes Medicine, 23*(5), 469-480.

Bandini, L. G., Must, A., Cyr, H., Anderson, S. E., Spadano, J. L., & Dietz, W. H. (2003). Longitudinal changes in the accuracy of reported energy intake in girls 10-15 y of age. *American Journal of Clinical Nutrition, 78*(3), 480-484.

Barr, S. I. (2006). Applications of Dietary Reference Intakes in dietary assessment and planning. *Applied Physiology, Nutrition and Metabolism, 31*(1), 66-73.

Brosnan, C. A., Upchurch, S., & Schreiner, B. (2001). Type 2 diabetes in children and adolescents: An emerging disease. *Journal of Pediatric Health Care, 15*(4), 187-193.

Burke, V. (2006). Obesity in childhood and cardiovascular risk. *Clinical and Experimental Pharmacology and Physiology, 33*(9), 831-837.

Canadian Fitness and Lifestyle Research Institute. (2004). 2004 Physical Activity Monitor [Electronic Version]. Retrieved December 7, 2006 from http://www.cflri.ca/eng/statistics/surveys/pam2004.php.

Canadian Fitness and Lifestyle Research Institute. (2006). 2005 Physical Activity Monitor [Electronic Version]. Retrieved December 15, 2006 from http://www.cflri.ca/eng/statistics/surveys/pam2005.php.

Crocker, P. R. E., Bailey, D. A., Faulkner, R. A., Kowalski, K. C., & McGrath, R. (1997). Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children. *Medicine and Science in Sports and Exercise, 29*(10), 1344-1349.

D'Alonzo, K. T. (2004). The Johnson-Neyman procedure as an alternative to ANCOVA. *Western Journal of Nursing Research, 26*(7), 804-812.

Dietz, W. H. (1998). Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics, 101*(3), 518-525.

ESHA Research. (1987 - 2002). The Food Processor, Nutrition Analysis and Fitness Software (Version 7.9). Salem, OR.

Freedman, D. S., Khan, L. K., Serdula, M. K., Dietz, W. H., Srinivasan, S. R., & Berenson, G. S. (2005). The relation of childhood BMI to adult adiposity: the Bogalusa Heart Study. *Pediatrics, 115*(1), 22-27.

French, S. A., Story, M., Neumark-Sztainer, D., Fulkerson, J. A., & Hannan, P. (2001). Fast food restaurant use among adolescents: associations with nutrient intake, food choices and behavioral and psychosocial variables. *International Journal of Obesity and Related Metabolic Disorders, 25*(12), 1823-1833.

Garriguet, D. (2004). Overview of Canadians' eating habits [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/82-620-MIE2006002.pdf.

Ginsburg, K. R., Slap, G. B., Cnaan, A., Forke, C. M., Balsley, C. M., & Rouselle, D. M. (1995). Adolescents' perceptions of factors affecting their decisions to seek health care. *Journal of the American Medical Association, 273*(24), 1913-1918.

Glanville, N. T., & McIntyre, L. (2006). Diet quality of Atlantic families headed by single mothers. *Canadian Journal of Dietetic Practice and Research, 67*(1), 28-35.

Gordon-Larsen, P., Nelson, M. C., Page, P., & Popkin, B. M. (2006). Inequality in the built environment underlies key health disparities in physical activity and obesity. *Pediatrics, 117*(2), 417-424.

Gray-Donald, K., Jacobs-Starkey, L., & Johnson-Down, L. (2000). Food habits of Canadians: reduction in fat intake over a generation. *Canadian Journal of Public Health, 91*(5), 381-385.

Guo, S. S., Roche, A. F., Chumlea, W. C., Gardner, J. D., & Siervogel, R. M. (1994). The predictive value of childhood body mass index values for overweight at age 35 y. *American Journal of Clinical Nutrition, 59*, 810-819.

Guo, S. S., Wu, W., Chumlea, W. C., & Roche, A. F. (2002). Predicting overweight and obesity in adulthood from body mass index values in childhood and adolescence. *American Journal of Clinical Nutrition, 76*(3), 653-658.

Hampl, S. E., Carroll, C. A., Simon, S. D., & Sharma, V. (2007). Resource utilization and expenditures for overweight and obese children. *Archives of Pediatrics & Adolescent Medicine 161*(1), 11-14.

Hanning, R., & Health Behaviour Research Group. (2004). University of Waterloo: Food Behaviour Survey.

Hanning, R., Lambraki, I., MacDonald, C., McCargar, L., Health Behaviour Research Group, & Beyond an Apple a Day Research Group. (2004). *A web-based approach to nutritional assessment in schools.* Paper presented at the International Congress of Dietetics, Chicago, Illinois.

Hanning, R. M., Jessup, L., Lambraki, I., MacDonald, C., & McCargar, L. (2003). *A web-based approach to assessment of food intake and behaviour of school children and adolescents.* Paper presented at the Canadian Foundation for Dietetic Research Symposium, Calgary, Alberta.

Health Canada. (1992). Canada's Food Guide to Healthy Eating [Electronic Version]. Retrieved December 7, 2006 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/fg_rainbow-arc_en_ciel_ga_e.pdf.

Health Canada. (2001). Canadian Nutrient File [Electronic Version] from http://www.hc-sc.gc.ca/food-aliment/ns-sc/nr-rn/surveillance/cnf-fcen/e_index.html.

Health Canada. (2007). Eating Well with Canada's Food Guide [Electronic Version]. Retrieved February 8, 2007 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/view_eatwell_vue_bienmang_e.pdf.

Health Canada and the Canadian Society for Exercise Physiology. (2002). Canada's Physical Activity Guide for Youth [Electronic Version]. Retrieved December 7, 2006 from http://www.phac-aspc.gc.ca/pau-uap/paguide/child_youth/pdf/guide_y_en.pdf.

Institute of Medicine. (1997). *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. Washington: National Academy Press.

Institute of Medicine. (1998). *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline*. Washington: National Academy Press.

Institute of Medicine. (2000a). *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*. Washington: National Academy Press.

Institute of Medicine. (2000b). *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids*. Washington: National Academy Press.

Institute of Medicine. (2000c). *Dietary Reference Intakes: Applications in Dietary Assessment*. Washington: National Academy Press.

Institute of Medicine. (2005). *Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (Macronutrients).* Washington: National Academy Press.

Jacobs Starkey, L., Johnson-Down, L., & Gray-Donald, K. (2001). Food habits of Canadians: comparison of intakes in adults and adolescents to Canada's food guide to healthy eating. *Canadian Journal of Dietetic Practice and Research, 62*(2), 61-69.

Janssen, I., Boyce, W. F., Simpson, K., & Pickett, W. (2006). Influence of individual- and area-level measures of socioeconomic status on obesity, unhealthy eating, and physical inactivity in Canadian adolescents. *American Journal of Clinical Nutrition, 83*(1), 139-145.

Katzmarzyk, P. T., & Janssen, I. (2004). The economic costs associated with physical inactivity and obesity in Canada: an update. *Canadian Journal of Applied Physiology, 29*(1), 90-115.

Kowalski, K. C., Crocker, P. R. E., & Donen, R. M. (2004). The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) manual [Electronic Version] from http://hkin.educ.ubc.ca/behavioural/PAQ%20manual.pdf.

Kowalski, K. C., Crocker, P. R. E., & Faulkner, R. A. (1997). Validation of the Physical Activity Questionnaire for Older Children. *Pediatric Exercise Science, 9*, 174-186.

Livingstone, M. B., Prentice, A. M., Coward, W. A., Strain, J. J., Black, A. E., Davies, P. S. W., Stewart, C. M., McKenna, P. G., & Whitehead, R. G. (1992). Validation of estimates of energy intake by weighed dietary record and diet history in children and adolescents. *American Journal of Clinical Nutrition, 56*(1), 29-35.

Lowik, M. R., Hulshof, K. F., & Brussaard, J. H. (1999). Food-based dietary guidelines: some assumptions tested for The Netherlands. *Br J Nutr, 81 Suppl 2*, S143-149.

Minaker, L. M., McCargar, L., Lambraki, I., Jessup, L., Driezen, P., Calengor, K., & Hanning, R. M. (2006). School region socio-economic status and geographic locale is associated with food behaviour of Ontario and Alberta adolescents. *Canadian Journal of Public Health, 97*(5), 357-361.

Must, A., & Strauss, R. S. (1999). Risks and consequences of childhood and adolescent obesity. *International Journal of Obesity and Related Metabolic Disorders, 23 Suppl 2*, S2-S11.

Neumark-Sztainer, D., Story, M., Hannan, P. J., Perry, C. L., & Irving, L. M. (2002). Weight-related concerns and behaviors among overweight and nonoverweight adolescents: implications for preventing weight-related disorders. *Archives of Pediatrics and Adolescent Medicine, 156*(2), 171-178.

Neumark-Sztainer, D., Wall, M. M., Story, M., & Perry, C. L. (2003). Correlates of unhealthy weight-control behaviors among adolescents: implications for prevention programs. *Health Psychology, 22*(1), 88-98.

Nusser, S. M., Carriquiry, A. L., Dodd, K. W., & Fuller, W. A. (1996). A semiparametric transformation approach to estimating usual daily intake distributions. *Journal of the American Statistical Association, 91*(436), 1440-1449.

Patricia, M. C. M., Waijers, P. M., Feskens, E. J., & Ocke, M. C. (2007). A critical review of predefined diet quality scores. *Br J Nutr, 97*(2), 219-231.

Raine, K. D. (2004). Overweight and obesity in Canada: A population health perspective [Electronic Version]. *Canadian Population Health Initiative*, 1-81 from http://www.cihi.ca/cihiweb/dispPage.jsp?cw_page=GR_1130_E.

Rampersaud, G. C., Pereira, M. A., Girard, B. L., Adams, J., & Metzl, J. D. (2005). Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *Journal of the American Dietetic Association, 105*(5), 743-760.

Serdula, M. K., Ivery, D., Coates, R. J., Freedman, D. S., Williamson, D. F., & Byers, T. (1993). Do obese children become obese adults? A review of the literature. *Preventive Medicine, 22*(2), 167-177.

Shatenstein, B., Nadon, S., & Ferland, G. (2003). Diet quality among older Quebecers as assessed by simple indicators. *Can J Diet Pract Res, 64*(4), 174-180.

Shatenstein, B., Nadon, S., Godin, C., & Ferland, G. (2005). Diet quality of Montreal-area adults needs improvement: estimates from a self-administered food frequency questionnaire furnishing a dietary indicator score. *Journal of the American Dietetic Association, 105*(8), 1251-1260.

Shields, M. (2005). Measured obesity: Overweight Canadian children and adolescents [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/2005001/pdf/cobesity.pdf.

Supple, A. J., Aquilino, W. S., & Wright, D. L. (1999). Collecting sensitive self-report data with laptop computers: Impact on the response tendencies of adolescents in a home interview. *Journal of Research on Adolescence, 9*(4), 467-488.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate Statistics* (5th ed.). New York: Pearson Education, Inc.

Veugelers, P. J., Fitzgerald, A. L., & Johnston, E. (2005). Dietary intake and risk factors for poor diet quality among children in Nova Scotia. *Canadian Journal of Public Health, 96*(3), 212-216.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *The New England Journal of Medicine, 337*(13), 869-873.

Chapter 7: Nutrition and physical activity variables associated with weight status in adolescents as assessed by the Web-Survey of Physical Activity and Nutrition (Web-SPAN)

7.1 Preface

The following chapter is based on data from a self-administered web-based survey that was conducted in the province of Alberta. Grade 7 through 10 students (n = 4097) participated. This was the same study and cohort as presented in Chapter 6, however data in this chapter were examined to specifically investigate the association of weight status and nutrition and physical activity. Data were collected between January and November 2005 using *Web-SPAN (Web-Survey of Physical Activity and Nutrition)*, a web-based survey that was developed at the University of Waterloo and modified by researchers at the University of Alberta.

7.2 Introduction

According to the World Health Organization, over 1.6 billion adults (15 years or older) are overweight, while 400 million are obese worldwide. It is projected that by the year 2015, 2.3 billion adults will be overweight and 700 million will be obese (World Health Organization, 2006). This rising epidemic is not limited to specific age groups, socioeconomic groups, or even developed countries. Obesity is being observed virtually everywhere, and affecting the health of individuals worldwide (World Health Organization, 2007).

The obesity epidemic is of concern in Canadian adolescents due to the dramatic increase in prevalence of overweight and obesity over the past 25 years (Shields, 2005). Further, numerous health consequences of adolescent obesity exist including risk for cardiovascular disease, type 2 diabetes (Brosnan, Upchurch, & Schreiner, 2001), metabolic syndrome (Alberti, Zimmet, & Shaw, 2006) and persistence of obesity into adulthood (Freedman et al., 2005; Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Guo, Wu, Chumlea, & Roche, 2002; Serdula et al., 1993; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Equally concerning are psychosocial consequences such as discrimination and teasing that may occur, which can have a long term affect on self-esteem and body image (Dietz, 1998; Must & Strauss, 1999). Obesity presents an enormous burden to our health care system, which is only expected to increase with the dramatic rise in obesity prevalence (Katzmarzyk & Janssen, 2004).

Obesity is a complex condition involving individual/behavioural, environmental and social factors; however it has been proposed that a basic imbalance of energy intake and energy expenditure leads to increased adiposity (Ruvession & Tataranni, 1997).

Specifically, individual behaviours such as increased consumption of high calorie, low nutrient dense foods, physical inactivity, and increased sedentary activity have been identified as key factors contributing to the development of obesity. The association between dietary fat and weight status is inconclusive (Gazzaniga & Burns, 1993; Gillis, Kennedy, Gillis, & Bar-Or, 2002; Maffeis, Pinelli, & Schutz, 1996; Nguyen, Larson, Johnson, & Goran, 1996; Obarzanek et al., 1994; Troiano, Briefel, Carroll, & Bialostosky, 2000; Tucker, Seljaas, & Hager, 1997). However, sub-optimal nutritional intakes including low intakes of foods found in Canada's Food Guide to Healthy Eating (CFGHE) (Shields, 2005), and high intakes of Other Foods, especially high calorie beverages have often been associated with obesity (Ludwig, Peterson, & Gortmaker, 2001; Sanigorski, Bell, & Swinburn, 2007; Striegel-Moore et al., 2006).

Specific meal behaviours including breakfast skipping and consumption of meals from fast food outlets have been associated with unfavorable nutritional intakes (Chapter 4; Chapter 6), including higher intakes of total energy, percent of energy from fat, daily servings of soft drinks, and lower intakes of fruit, vegetables and milk (French, Story, Neumark-Sztainer, Fulkerson, & Hannan, 2001). Further, a study by Rampersaud et al. (2005) indicated that breakfast skipping is highly prevalent in the adolescent population, and is associated with increased prevalence of overweight.

Although it is generally assumed that overweight or obese adolescents are less active than their non-overweight peers (for the purpose of the current study, the term non-overweight included both non-overweight and non-obese individuals), research in this area has been inconclusive (Shields, 2005), which is likely due to difficulties associated with measurement of physical activity (Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997).

Although several studies have examined the relationship between overweight/obesity and obesity determinants including dietary intake (Shields, 2005), meal behaviours (Janssen, Katzmarzyk, Boyce, King, & Pickett, 2004) and physical activity (Thompson et al., 2005), few studies have been conducted that simultaneously examined obesity determinants in a large province-wide sample which allows for comparisons between these behaviours. It is hypothesized that non-overweight students will have different intakes including lower intakes of fat and Other Foods, and a lower frequency of meal skipping and consuming meals away from home. Further, it is believed that non-overweight students will be more active than their overweight and obese peers. Therefore the purpose of this study was to investigate the current overweight and obesity status of Alberta adolescents and to identify whether non-overweight students were different from their overweight or obese peers with respect to macronutrient intakes, consumption of Other Foods, sub-optimal meal behaviours including breakfast skipping and consuming meals away from home, and physical activity levels.

7.3 Methods

7.3.1 Participants

The Web-Survey of Physical Activity and Nutrition (Web-SPAN) was a self-administered web-based survey of students in grade 7 to 10 in the province of Alberta, Canada that assessed nutrition, physical activity, related meal behaviours, and self-reported height and weight. To maximize school recruitment and reduce the impact of cluster randomization caused by the lack of variability between students within school boards and schools, all 59 public and separate (Catholic) school boards (public, Catholic; rural, urban) in the province were selected for participation which helped to improve the representativeness of the sample. Forty-eight school boards agreed to participate (81%), and an average of seven schools within each school board were randomly chosen and contacted after obtaining school board approval. In addition, private schools were randomly selected based on regional diversity, as per Alberta Education Zones. School boards, schools and teachers were individually contacted by mail (detailed information package) (**Appendix H1, H2, H3, H4, H5**) and follow-up phone calls were made to request permission to survey grade 7 through 10 students. Parents and students received information letters (**Appendix H6, H7, H8**), and parental consent was obtained using active consent (**Appendix H9**). Students accessed the website using their unique login and password that was distributed randomly on the day of the survey. All students provided assent after signing on to the web-based survey (**Appendix H10**).

This research was approved by the University of Alberta Human Research Ethics Board in the Faculty of Agriculture, Forestry, and Home Economics (**Appendix I**), the Cooperative Activities Program in the Faculty of Education at the University of Alberta, and from each participating school board and school. The anonymous 24 page survey took approximately 45 minutes to complete and was conducted during class time within the school day. Survey data were collected between January and November 2005 (except in July and August when schools were closed for summer), and thus nutritional intakes may have been affected by seasonal variation.

7.3.2 Procedures

7.3.2.1 Weight Status

At the beginning of the survey, students provided self-reported height and weight. Body mass index was calculated (weight (kilograms)/height (meters^2)), and students were categorized as overweight or obese using the International Obesity Task Force (IOTF) cut-offs (Cole, Bellizzi, Flegal, & Dietz, 2000), as recommended for group comparisons in Canada (Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, & Community Health Nurses Association of Canada, 2004). Test-retest reliability for self-reported height and weight for Web-SPAN completed an average of 7.8 days apart on a subset of the sample, showed overall strong agreements (Intraclass Correlation Coefficients (ICC), Pearson r) for both height (ICC = 0.90, Pearson r = 0.90, n = 299) and weight (ICC = 0.98, Pearson r = 0.98, n = 333 weight). Further, Web-SPAN showed strong agreements for self-reported height (ICC = 0.88, Pearson r = 0.88, n = 364) and weight (ICC = 0.93, Pearson r = 0.94, n = 409) when compared to measured height and weight (Chapter 5, p. 142-144).

7.3.2.2 Dietary Intake

As part of Web-SPAN, a 24-hour web-based dietary recall was administered to students to measure dietary intake. Responding to the electronic survey questions, students reported all foods and beverages consumed during the previous day by selecting items from a list of approximately 500 foods. To help students recall their intake, portion size images and cues regarding beverage intake were provided.

The web-based 24-hour dietary recall has been validated using several methods. In comparison to a dietitian-administered 24-hour dietary recall, the web-based 24-hour dietary recall showed good agreement for total caloric intake and macronutrients (ICC = 0.51 to 0.68) when assessed over the same 24-hour period in grade 6 to 8 students (n = 51) (Hanning & Health Behaviour Research Group, 2004). In comparison to direct observation of food items selected at lunch hour versus those selected on the web-survey, grade 9 and 10 students (n = 15) showed an overall agreement of 87% (Hanning et al., 2004).

In addition, repeat comparisons for the web-based 24-hour dietary recall completed an average of 7.8 days apart on a subset of the sample (n = 379) showed overall good agreements for macronutrients (ICC = 0.45 to 0.64; Pearson r = 0.45 to 0.64). When compared to a 3-day food record, Web-SPAN revealed overall agreements for macronutrients where ICC values ranged from 0.26 to 0.35, and Pearson r values ranged from 0.28 to 0.37 (n = 369) (Chapter 5, p. 145-147).

A measure of diet quality was used to classify students into groups of poor, average or superior diet quality using a food-based diet quality index (Lowik, Hulshof, & Brussaard, 1999), as recommended by Patricia et al. (2007) and modified to reflect CFGHE (Health Canada, 1992) foods. Individuals consume food groups, and not individual nutrients, therefore food-based diet quality indices provide information that can easily be used for health promotion purposes. Further, food based diet quality indices have been validated using the Mean Adequacy Ratio (MAR), a measure of nutrient adequacy (Shatenstein, Nadon, & Ferland, 2003). In the current study, servings of each of the four food groups according to CFGHE (Health Canada, 1992) were calculated using data from the 24-hour dietary recall. Foods that were not classified as Grain Products, Vegetables and Fruit, Milk Products or Meat and Alternatives were categorized as Other Foods and further divided into sub-categories which included foods containing mostly sugar (e.g., candies), high salt/fat foods (e.g., potato chips), high calorie beverages (e.g., regular soft drinks), low calorie beverages (e.g., low calorie soft drinks), or high sugar/fat foods (e.g., pastries) based on Canadian Nutrient File definitions (Health Canada, 2001). Diet quality was defined using the number of minimum food group recommendations that were met based on CFGHE. Individuals were classified as having either poor (met 0-1 food group recommendation), average (met 2-3 food group recommendations), or superior (met all 4 food group recommendations) diet quality. Although not validated, the food groupings were supported by graded responses in key nutrient intakes in each group, where improvements in nutrient intakes were observed when diet quality increased from poor to average to superior (Chapter 4). Canada's Food Guide to Healthy Eating was recently revised and the new food guide, Eating Well with Canada's Food Guide (Health Canada, 2007), was released in early 2007. In spite of this, the 1992 CFGHE was the government recommendation during data collection and was also a component of Alberta school curriculum (Alberta Learning, 2002, 2005). Therefore, it was most appropriate to compare intakes to the 1992 CFGHE recommendations. Macronutrient intakes were assessed using ESHA Food Processor version 7.9 (ESHA Research, 1987 - 2002) and the 2001b Canadian Nutrient File (Health Canada, 2001) database.

7.3.2.3 Sub-Optimal Meal Behaviours

Survey questions examining sub-optimal meal behaviours (meal skipping and consuming meals away from home) are comparable to questions developed for Project EAT (Eating Among Teens), a well-established survey instrument (Neumark-Sztainer, Story, Hannan, Perry, & Irving, 2002; Neumark-Sztainer, Wall, Story, & Perry, 2003). Frequency of meal consumption was assessed by asking "How often do you usually eat?" followed by "breakfast", "lunch", "dinner", "morning snacks", afternoon snacks", or "evening snacks". Participants selected from the following response options: "Never", "On weekends only", "Less than half of the week (three or fewer days each week)", "More than half of the week (four or more days each week)", "Every day", and "Not answered". Frequency of consuming meals away from home was assessed by asking "How often do you eat meals or snacks prepared away from home?", with response options of "rarely or never", "once a month", "once a week", "2-6 times a week", and "once a day". The following locations were assessed: school cafeteria, fast food restaurant or take out, other restaurants, vending machines, snack bars (e.g., the canteen at an arena), and convenience stores.

7.3.2.4 Physical Activity

A web-based version of the Physical Activity Questionnaire for Older Children (PAQ-C) was used to assess physical activity levels. The PAQ-C was specifically designed for Canadian school-aged youth, and includes components on physical activity during the school day as well as after school and weekend activity (Kowalski, Crocker, & Donen, 2004). The questionnaire consists of 10 items, of which 9 are used to calculate an activity score. Responses are converted to a 5-point scale where a higher score represents greater levels of physical activity (scores range from 1.00 to 5.00). The PAQ-C was found to be a reliable and valid method to assess physical activity in 9 to 14 year old students (Crocker et al., 1997; Kowalski, Crocker, & Faulkner, 1997). In addition, test-retest reliability for the web-based PAQ-C completed an average of 7.8 days apart on a subset of the sample (n = 323), showed good agreements of 0.79 (ICC) and 0.79 (Pearson r). Further, when compared to the paper-based PAQ-C, the web-based PAQ-C showed good agreement (ICC = 0.70; Pearson r = 0.70) (n = 411) (Chapter 5, p. 147-148).

7.3.2.5 Statistical Analyses

Overweight and obesity prevalence were analyzed using descriptive statistics. A 2 X 3 multivariate analyses of co-variance (MANCOVA), with total caloric intake as the covariate was used to evaluate the association between gender (boys, girls) and BMI classification (non-overweight, overweight, obese). Univariate follow-up on significant MANCOVA results was completed for dependent variables which included nutrient intakes, servings of Other Foods, frequency of meal consumption, and frequency of consuming meals away from home. Prior to the MANCOVA analyses, the assumption of homogenous slopes (D'Alonzo, 2004; Tabachnick & Fidell, 2007) was tested, and interactions indicated that the slopes differed among levels of the independent variables. Therefore, adjusted values were based on custom models which included these interactions for the following MANCOVA analyses: macronutrients, Other Foods, and frequency of meal consumption. Significant main effects of gender were not presented in the current study. Differences in physical activity levels and diet quality scores between non-overweight, overweight and obese students were assessed using analysis of variance (ANOVA).

Statistical analyses were performed using the software program SPSS (version 15.0; SPSS Inc, Chicago). A criterion α-level of $p < 0.05$ was used for all statistical comparisons.

7.4 Results

7.4.1 Demographics

In total, 4981 adolescents participated in the study. Students with incomplete surveys (n = 9), and students with extreme values of BMI, total caloric intake or physical activity levels based on outlier analyses (non-mutually exclusive outliers: BMI, n = 35; total caloric intake, n = 24; physical activity, n = 14; total outliers removed, n = 71) were excluded. BMI classifications could not be determined on 804 students due to missing height and/or weight or other descriptive variables. Thus, a final sample of 4097 was included in the analyses (boys = 1974; girls = 2123; mean age = 13.7 years). During data collection, students were free to end the survey at any time, and were not required to answer every question in order to participate. Therefore, sample size varies throughout the analyses. In total, 363 schools were contacted of which 193 (53%) agreed to participate, 160 (44%) declined participation, and 10 (3%) were ineligible based on inappropriate grade levels. Upon completion of the study, final participation was 136 schools within 44 school boards, representing a 37% response rate at the school level and a 75% response rate at the school board level. This represents a convenience sample of

Alberta students. Reasons for refusal were generally due to time constraints throughout the school year.

7.4.2 Weight Status

Observed percentage of overweight and obesity, by gender, are presented in **Table 7.1.** In total, 21.1% of students (26.5% boys; 16.0% girls) were considered overweight or obese.

Table 7.1: Percentage of Overweight and Obesity, by Gender, Among Adolescents Aged 11 to 17 Years[*]

BMI Classification[†]	Total (n = 4097)	Boys (n = 1974)	Girls (n = 2123)
Overweight	15.1[‡]	19.0	11.4
Obese	6.0	7.5	4.6

[*] Four students were younger than age 11 due to mixed grade level classrooms

[†] Classified according to the International Obesity Task Force cut-offs (Cole et al., 2000)

[‡] Prevalence expressed as a percentage

7.4.2.1 BMI Classification and Nutrient Intakes

Multivariate F values for BMI classification (Wilks' Lambda = 1.00, F(8, 8134) = 3.46, p = 0.039) were significant, while the interaction between BMI classification and gender was not significant (Wilks' Lambda = 1.00, F(8, 8134) = 0.59, p = 0.788). Follow-up univariate analyses for BMI classification indicated that non-overweight students consumed significantly more carbohydrate and fibre, and significantly less fat compared to both overweight and obese students. Significant differences did not exist between overweight and obese students, or for protein intakes between BMI classifications. **Table 7.2** provides data on the macronutrient intake data grouped by BMI classification.

No significance was observed for the main effect of BMI classification (Wilks' Lambda = 1.00, F(10, 8132) = 0.88, p = 0.552) or the interaction between BMI classification and gender (Wilks' Lambda = 1.00, F(10, 8132) = 1.03, p = 0.417) with Other Foods sub-categories (MANCOVA). The results of comparisons between intakes from the Other Foods sub-categories and BMI classification are presented in **Table 7.2.** Although significant differences were not observed based on the MANCOVA, significance was observed for high calorie beverages based on univariate analyses where non-overweight students consumed significantly less high calorie beverages compared to obese students. No significant differences were observed between BMI classification and diet quality (χ^2 (4) = 5.31, p = 0.257, n = 4080).

Table 7.2: Group Differences in Adjusted[*] Nutrient Intakes Based on BMI Classification[†]

	BMI Classification[‡]			F Value	P Value
	Non-overweight[§]	Overweight	Obese		
Nutrients (g) (n = 4080)					
Carbohydrate	$284.09 \pm 0.99^{**,a}$	275.13 ± 2.25^{b}	$275.35 \pm 3.52^{b,c}$	8.88	$< 0.001^{ab}$; 0.016^{ac}
Protein	79.66 ± 0.46	81.95 ± 1.04	79.09 ± 1.63	2.25	nsd
Fat	77.36 ± 0.36^{a}	79.95 ± 0.82^{b}	$81.14 \pm 1.29^{b,c}$	7.51	$0.004^{ab,\ ac}$
Fibre	15.14 ± 0.13^{a}	13.97 ± 0.29^{b}	$13.79 \pm 0.46^{b,c}$	9.86	$< 0.001^{ab}$; 0.005^{ac}
Other Food Groups Sub-categories (servings/day) (n = 4080)					
Mostly Sugar	1.01 ± 0.03	0.91 ± 0.06	0.99 ± 0.10	1.12	nsd
High Salt/Fat	0.62 ± 0.02	0.58 ± 0.05	0.64 ± 0.07	0.29	nsd
High Calorie Beverages	0.79 ± 0.02	0.84 ± 0.05	1.09 ± 0.09	5.73	nsd[††]
Low Calorie Beverages	1.25 ± 0.04	1.30 ± 0.08	1.33 ± 0.12	0.35	nsd
High Sugar/Fat	0.67 ± 0.02	0.61 ± 0.04	0.54 ± 0.06	2.96	nsd

[*] Adjusted for total caloric intake (energy)

[†] Univariate analyses

[‡] Classified according to the International Obesity Task Force cut-offs (Cole et al., 2000)

[§] Non-overweight refers to all non-overweight, non-obese students

[**] Mean ± SE (the two decimal places represent statistical requirements, however the accuracy of the instrument is appropriate to the level of whole numbers only)

[††] significance was not observed based on multivariate analysis, however univariate analysis revealed significance between non-overweight and obese students (p = 0.003)

[a,b,c] Different superscript letters in each row indicate significant statistical differences

Abbreviations: BMI (body mass index), g (grams), SE (standard error of the mean), nsd (no significant difference)

7.4.2.2 BMI Classification and Sub-Optimal Meal Behaviours

Significant main effects for BMI classification (Wilks' Lambda = 0.99, F(8, 6202) = 2.88, p = 0.003), but not for the interaction between BMI classification and gender (Wilks' Lambda = 1.00, F(8, 6202) = 0.77, p = 0.627) were observed when meal frequency was assessed using MANCOVA. Follow-up univariate analyses revealed that non-overweight students had a higher frequency of consuming breakfast and snacks compared to obese students. Non-overweight students also consumed snacks more frequently than overweight students. No differences were observed for lunch or dinner consumption (**Table 7.3**).

The association between BMI classification and gender with frequency of consuming meals away from home assessed using a MANCOVA did not reveal significant F values for BMI classification (Wilks' Lambda = 1.00, F(12, 7034) = 1.44, p = 0.140) or the interaction between BMI classification and gender (Wilks' Lambda = 1.00, F(12, 7034) = 1.27, p = 0.227) (**Table 7.3**).

Table 7.3: Group Differences in Sub-Optimal Meal Behaviours* Based on BMI Classification†

	BMI Classification‡			F Value	P Value
	Non-overweight§	Overweight	Obese		
Meal Frequency** (n = 3114)					
Breakfast	$4.25 \pm 0.03^{\dagger\dagger, a}$	4.14 ± 0.06	4.02 ± 0.09^{c}	4.35	0.014^{ac}
Lunch	4.66 ± 0.02	4.64 ± 0.04	4.51 ± 0.06	2.95	nsd
Dinner	4.87 ± 0.01	4.89 ± 0.02	4.78 ± 0.04	2.83	nsd
Snacks	3.55 ± 0.02^{a}	3.31 ± 0.05^{b}	$3.25 \pm 0.08^{b,c}$	16.67	$< 0.001^{ab, ac}$
Consuming Meals and Snacks Away From Home‡‡ (n = 3529)					
School Cafeteria	2.33 ± 0.03	2.35 ± 0.06	2.40 ± 0.10	0.27	nsd
Fast Food/Take Out	2.31 ± 0.02	2.26 ± 0.04	2.19 ± 0.06	2.40	nsd
Other Restaurant	2.05 ± 0.02	2.08 ± 0.04	2.06 ± 0.06	0.37	nsd
Vending Machines	2.19 ± 0.02	2.16 ± 0.05	2.18 ± 0.08	0.22	nsd
Snack Bars	2.25 ± 0.02	2.15 ± 0.05	2.17 ± 0.08	1.93	nsd
Convenience Store	2.52 ± 0.02	2.51 ± 0.05	2.56 ± 0.08	0.20	nsd

[*] Adjusted for total caloric intake (energy)

[†] Univariate analyses

[‡] Classified according to the International Obesity Task Force cut-offs (Cole et al., 2000)

[§] Non-overweight refers to all non-overweight, non-obese students

[**] Meal Frequency: never = 1, on weekends only = 2, less than half of the week (three or fewer days each week) = 3, more than half of the week (four or more days each week) = 4, every day = 5; Snacks were averaged before analysis (morning snacks, afternoon snacks, evening snacks)

[††] Mean ± SE

[‡‡] Consuming Meals and Snacks Away From Home: rarely or never = 1, once a month = 2, once a week = 3, 2-6 times a week = 4, once a day = 5

[a,b,c] Different superscript letters in each row indicate significant statistical differences

Abbreviations: BMI (body mass index), SE (standard error of the mean), nsd (no significant difference)

7.4.3 Physical Activity

Significant differences were observed in physical activity levels between non-overweight and obese students, and between overweight and obese students ($F(2, 3669) = 15.78$, $p < 0.001$) based on ANOVA. Both non-overweight (2.92 ± 0.01 (SE), $p < 0.001$) and overweight students (2.89 ± 0.03, $p < 0.001$) were more active than obese students (2.66 ± 0.05). Differences were also observed between BMI classifications based on gender for both boys ($F(2, 1747) = 23.12$, $p < 0.001$) and girls ($F(2, 1919) = 3.07$, $p = 0.047$) when assessed using ANOVA. Both non-overweight (3.06 ± 0.02, $p < 0.001$) and overweight boys (3.00 ± 0.04, $p < 0.001$) were more active than obese boys (2.63 ± 0.06), while non-overweight girls (2.81 ± 0.02, $p = 0.048$) were more active than obese girls (2.70 ± 0.07).

7.5 Discussion

The purpose of this study was to investigate the current overweight and obesity status of Alberta adolescents, and to identify differences in nutrient intakes, meal behaviours and physical activity levels between BMI classifications. In the current study one in five (~21%) students were considered overweight or obese. They had significantly different nutrient intakes, meal behaviours and physical activity levels than non-overweight students, such that sub-optimal behaviours were more prevalent in students that were classified as overweight or obese.

7.5.1 Weight Status

Self-reported height and weight was used to calculate BMI and to further classify students as overweight or obese. Although measured height and weight are more precise and accurate than self-reported measurements, self-report is a useful method that offers researchers a time- and cost-effective method to survey a large number of participants simultaneously. Several studies have examined the reliability and validity of self-reported height and weight compared to measured height and weight and showed good agreement overall between the two methods (Brener, McManus, Galuska, Lowry, & Wechsler, 2003; Hanning, Jessup, Lambraki, MacDonald, & McCargar, 2003; Himes & Faricy, 2001; Strauss, 1999). Further, Web-SPAN showed strong agreements for self-reported height and weight when compared to measured height and weight.

In total 21.1% of students were overweight or obese, while 26.5% of boys and 16.0% of girls were considered overweight or obese. These results are similar to data from the 2004 CCHS, which indicated that 22% of Alberta youth (2 to 17 years) were overweight or obese (Shields, 2005). The 2004 CCHS revealed that Alberta youth had a significantly lower prevalence of overweight/obese than the national average (22% versus 26%), therefore it was most appropriate to compare to provincial statistics (Shields, 2005). Although the 2004 CCHS examined adolescents 12 to 17 years separately (overweight/obese prevalence = 29%), data are not available separated by province for comparisons (Shields, 2005).

In comparison to a study by Janssen and colleagues (2004), which assessed a nationally representative sample of Canadian adolescents (n = 5,890) aged 11 to 16 years, percentage of overweight/obesity was again similar to the current study. Boys had a prevalence rate of 24.1% and girls were at 16.8% (Janssen et al., 2004). Thus the results of the current study are in agreement with other provincial and national studies. The similarities between the 2004 CCHS (measured height and weight), the study by Janssen and colleagues (self-reported height and weight) and the current study (self-reported height and weight) demonstrates the utility of using self-report to assess obesity related behaviours in cross-sectional studies.

7.5.1.1 BMI Classification and Nutrient Intakes

The association between dietary fat and weight status is inconclusive, as several researchers have suggested that an increase in dietary fat intake can be correlated to an increase in body fat in children ages 4 to 11 years (Gazzaniga & Burns, 1993; Maffeis et al., 1996; Nguyen et al., 1996; Obarzanek et al., 1994; Tucker et al., 1997), while Gillis and colleagues (2002) demonstrated a stronger effect between dietary energy intake and obesity and Troiano et al. (2000) showed a decrease in fat intake despite an increase in the prevalence of overweight. In the current study, both overweight and obese students consumed significantly more total fat compared to non-overweight students, suggesting a relationship between dietary fat intake and BMI classification. In addition, overweight and obese students had significantly lower intakes of carbohydrate and fibre compared to their peers. Although mean intakes of total fibre were well below the recommended Dietary Reference Intake (DRI) in all BMI categories, higher intakes were observed in non-overweight students, representing an improvement in fibre intake with decreasing BMI. Significant differences were not observed between BMI classification and diet quality, however recent findings from the 2004 CCHS suggested that youth who consumed fruits and vegetables more frequently (five or more times a day) were less likely to be classified as overweight/obese (Shields, 2005). Further research, such as the 2004 CCHS, that examines the relationship between weight and additional CFGHE food groups may provide important information in the area of obesity determinants.

Although multivariate results did not indicate significance for the consumption of Other Foods sub-categories, univariate analysis revealed that obese students consumed significantly more high calorie beverages compared to non-overweight students. The relationship between high calorie beverages (e.g., regular soft drinks) and body weight is of interest due to the tremendous increase in soft drink consumption in the adolescent population. In the United States, data from the National Heart, Lung, and Blood Institute Growth and Health Survey assessed longitudinal changes in beverage consumption among 2,371 girls. Girls were assessed initially at age 9 or 10 years and annually up until 19 years of age. Data from multiple 3-day food records indicated that regular soft drink consumption nearly tripled over the 10 year period. In this study, for every 100 grams of regular soft drinks consumed, BMI increased by 0.01 unit and average daily caloric intake increased by approximately 82 kilocalories (Striegel-Moore et al., 2006). A more recent Australian study indicated that schoolchildren aged 4 to 12 years who consumed greater intakes of high calorie beverages were 2.1 times (fruit juice/drink) or 2.2 times (soft drinks) more likely to be overweight/obese (Sanigorski et al., 2007). A meta-analysis which examined the effects of soft drink consumption on nutrition and health supports the results of the current study and revealed positive associations between soft drink consumption and body weight, although results varied depending on the methodology used to assess body weight (Vartanian, Schwartz, & Brownell, 2007).

7.5.1.2 BMI Classification and Sub-Optimal Meal Behaviours

Results of the present study indicated that non-overweight students had a higher frequency of consuming breakfast and snacks when compared to either overweight or obese students. Breakfast skipping is highly prevalent in the adolescent population, and consistent with previous reports, has been associated with increased prevalence of overweight (Rampersaud et al., 2005). Although snack consumption has been previously associated with higher intakes of Other Foods (Garriguet, 2004), the current study suggests that snacks may be associated with improvements in BMI classification. Although it could not be determined in the current study, one explanation is that students who skipped breakfast supplemented their intake with a morning snack. Alternatively, those that consumed snacks may have had higher levels of physical activity, thus requiring additional energy intake. Additional research that examines meal patterns may be helpful in clarifying the association between snack consumption and weight.

Although significant differences were not observed between BMI classification and consumption of meals and snacks away from home, previous studies have found a positive association (Niemeier, Raynor, Lloyd-Richardson, Rogers, & Wing, 2006; Veugelers & Fitzgerald, 2005). In the current study, the frequency of family meals was not examined. Family meals may have been a better indicator of BMI classification than consumption of meals away from home at independent locations. Family members may have been present when meals were consumed away from home, which could have had a greater effect on energy intake than the location alone.

7.5.2 Physical Activity

Results from the current study indicated that both non-overweight and overweight students were more active than obese students. Further, differences were observed by gender where both non-overweight and overweight boys were more active than obese boys, and non-overweight girls were more active than obese girls. These findings are consistent with results from the 2004 CCHS which indicated that sedentary adolescent boys were more likely than active boys to be obese (Shields, 2005). However, these results are dissimilar to other reports that utilized objective measuring devices for physical activity such as the study done by Thompson et al. (2005), where no significant differences were found in physical activity levels (measured using accelerometers) among BMI classifications.

A limitation of this study was the use of self-reported survey data. However, validated survey components were used to help reduce recall bias, response bias, and underreporting of total energy intake which is known to occur in the adolescent population (Bandini et al., 2003; Livingstone et al., 1992). Strengths of this study include the large sample size in addition to the anonymity and privacy that the survey provided. Anonymity and privacy are important determinants of adolescents' decision to report honest answers (Ginsburg et al., 1995; Supple, Aquilino, & Wright, 1999) and help to reduce the effect of social desirability. Further, students were not aware in advance what day the survey was to be completed, therefore reducing reactivity.

In conclusion, this study examined the overweight and obesity status of Alberta adolescents and the associations between BMI classification and lifestyle behaviours including nutrient intakes, meal behaviours, and levels of physical activity. Significant differences in intake, meal behaviours and physical activity levels existed between BMI classifications. This research supports the need to target sub-optimal behaviours such as high calorie beverage consumption, total fat intake, breakfast skipping and low levels of physical activity in order to promote healthy weights in the adolescent population. Because behaviours established during adolescence have been shown to track into adulthood, it is important to target these behaviours during early adolescence. In Alberta, vending machines have been removed from many schools and daily physical activity is mandatory in grades 1-9; however, this research supports the need to focus on all adolescents, including those in grades 10 through 12. Additional nutrition education in schools may also help target sub-optimal nutritional intakes such as high intakes of total fat and low intakes of fibre, by educating students on the importance of a healthy diet. Thus, priorities that aim to improve the school environment such as additional nutrition education, removal of vending machines, and mandatory physical activity may help to improve overall weight status in Alberta adolescents. Further, priorities should be developed that target students in all grade levels, including high school students. It should be noted that plans have been established to review daily physical activity in Alberta high schools.

7.6 References

Alberta Learning. (2002). Health and life skills, kindergarten to grade 9 [Electronic Version]. Retrieved December 7, 2006 from http://www.education.gov.ab.ca/k_12/curriculum/bySubject/healthpls/health.pdf.

Alberta Learning. (2005). Career and technology studies [Electronic Version]. Retrieved December 7, 2006 from http://www.education.gov.ab.ca/k%5F12/curriculum/bySubject/cts/foods/fodpos.pdf.

Alberti, K. G., Zimmet, P., & Shaw, J. (2006). Metabolic syndrome--a new world-wide definition. A Consensus Statement from the International Diabetes Federation. *Diabetes Medicine, 23*(5), 469-480.

Bandini, L. G., Must, A., Cyr, H., Anderson, S. E., Spadano, J. L., & Dietz, W. H. (2003). Longitudinal changes in the accuracy of reported energy intake in girls 10-15 y of age. *American Journal of Clinical Nutrition, 78*(3), 480-484.

Brener, N. D., McManus, T., Galuska, D. A., Lowry, R., & Wechsler, H. (2003). Reliability and validity of self-reported height and weight among high school students. *Journal of Adolescent Health, 32*(4), 281-287.

Brosnan, C. A., Upchurch, S., & Schreiner, B. (2001). Type 2 diabetes in children and adolescents: An emerging disease. *Journal of Pediatric Health Care, 15*(4), 187-193.

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal (clinical research ed.), 320*(7244), 1240-1243.

Crocker, P. R. E., Bailey, D. A., Faulkner, R. A., Kowalski, K. C., & McGrath, R. (1997). Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children. *Medicine and Science in Sports and Exercise, 29*(10), 1344-1349.

D'Alonzo, K. T. (2004). The Johnson-Neyman procedure as an alternative to ANCOVA. *Western Journal of Nursing Research, 26*(7), 804-812.

Dietitians of Canada, Canadian Paediatric Society, The College of Family Physicians of Canada, & Community Health Nurses Association of Canada. (2004). The use of growth charts for assessing and monitoring growth in Canadian infants and children. *Canadian Journal of Dietetic Practice and Research, 65*(1), 22-32.

Dietz, W. H. (1998). Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics, 101*(3), 518-525.

ESHA Research. (1987 - 2002). The Food Processor, Nutrition Analysis and Fitness Software (Version 7.9). Salem, OR.

Freedman, D. S., Khan, L. K., Serdula, M. K., Dietz, W. H., Srinivasan, S. R., & Berenson, G. S. (2005). The relation of childhood BMI to adult adiposity: the Bogalusa Heart Study. *Pediatrics, 115*(1), 22-27.

French, S. A., Story, M., Neumark-Sztainer, D., Fulkerson, J. A., & Hannan, P. (2001). Fast food restaurant use among adolescents: associations with nutrient intake, food choices and behavioral and psychosocial variables. *International Journal of Obesity and Related Metabolic Disorders, 25*(12), 1823-1833.

Garriguet, D. (2004). Overview of Canadians' eating habits [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/82-620-MIE2006002.pdf.

Gazzaniga, J. M., & Burns, T. L. (1993). Relationship between diet composition and body fatness, with adjustment for resting energy expenditure and physical activity, in preadolescent children. *American Journal of Clinical Nutrition, 58*, 21-28.

Gillis, L. J., Kennedy, L. C., Gillis, A. M., & Bar-Or, O. (2002). Relationship between juvenile obesity, dietary energy and fat intake and physical activity. *International Journal of Obesity, 26*, 458-463.

Ginsburg, K. R., Slap, G. B., Cnaan, A., Forke, C. M., Balsley, C. M., & Rouselle, D. M. (1995). Adolescents' perceptions of factors affecting their decisions to seek health care. *Journal of the American Medical Association, 273*(24), 1913-1918.

Guo, S. S., Roche, A. F., Chumlea, W. C., Gardner, J. D., & Siervogel, R. M. (1994). The predictive value of childhood body mass index values for overweight at age 35 y. *American Journal of Clinical Nutrition, 59*, 810-819.

Guo, S. S., Wu, W., Chumlea, W. C., & Roche, A. F. (2002). Predicting overweight and obesity in adulthood from body mass index values in childhood and adolescence. *American Journal of Clinical Nutrition, 76*(3), 653-658.

Hanning, R., & Health Behaviour Research Group. (2004). University of Waterloo: Food Behaviour Survey.

Hanning, R., Lambraki, I., MacDonald, C., McCargar, L., Health Behaviour Research Group, & Beyond an Apple a Day Research Group. (2004). *A web-based approach to nutritional assessment in schools.* Paper presented at the International Congress of Dietetics, Chicago, Illinois.

Hanning, R. M., Jessup, L., Lambraki, I., MacDonald, C., & McCargar, L. (2003). *A web-based approach to assessment of food intake and behaviour of school children and adolescents.* Paper presented at the Canadian Foundation for Dietetic Research Symposium, Calgary, Alberta.

Health Canada. (1992). Canada's Food Guide to Healthy Eating [Electronic Version]. Retrieved December 7, 2006 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/fg_rainbow-arc_en_ciel_ga_e.pdf.

Health Canada. (2001). Canadian Nutrient File [Electronic Version] from http://www.hc-sc.gc.ca/food-aliment/ns-sc/nr-rn/surveillance/cnf-fcen/e_index.html.

Health Canada. (2007). Eating Well with Canada's Food Guide [Electronic Version]. Retrieved February 8, 2007 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/view_eatwell_vue_bienmang_e.pdf.

Himes, J. H., & Faricy, A. (2001). Validity and reliability of self-reported stature and weight of US adolescents. *American Journal of Human Biology, 13*(2), 255-260.

Janssen, I., Katzmarzyk, P. T., Boyce, W. F., King, M. A., & Pickett, W. (2004). Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns. *Journal of Adolescent Health, 35*(5), 360-367.

Katzmarzyk, P. T., & Janssen, I. (2004). The economic costs associated with physical inactivity and obesity in Canada: an update. *Canadian Journal of Applied Physiology, 29*(1), 90-115.

Kowalski, K. C., Crocker, P. R. E., & Donen, R. M. (2004). The Physical Activity Questionnaire for Older Children (PAQ-C) and Adolescents (PAQ-A) manual [Electronic Version] from http://hkin.educ.ubc.ca/behavioural/PAQ%20manual.pdf.

Kowalski, K. C., Crocker, P. R. E., & Faulkner, R. A. (1997). Validation of the Physical Activity Questionnaire for Older Children. *Pediatric Exercise Science, 9*, 174-186.

Livingstone, M. B., Prentice, A. M., Coward, W. A., Strain, J. J., Black, A. E., Davies, P. S. W., Stewart, C. M., McKenna, P. G., & Whitehead, R. G. (1992). Validation of estimates of energy intake by weighed dietary record and diet history in children and adolescents. *American Journal of Clinical Nutrition, 56*(1), 29-35.

Lowik, M. R., Hulshof, K. F., & Brussaard, J. H. (1999). Food-based dietary guidelines: some assumptions tested for The Netherlands. *Br J Nutr, 81 Suppl 2*, S143-149.

Ludwig, D. S., Peterson, K. E., & Gortmaker, S. L. (2001). Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet, 357*(9255), 505-508.

Maffeis, C., Pinelli, L., & Schutz, Y. (1996). Fat intake and adiposity in 8 to 11-year-old obese children. *International Journal of Obesity and Related Metabolic Disorders, 20*(2), 170-174.

Must, A., & Strauss, R. S. (1999). Risks and consequences of childhood and adolescent obesity. *International Journal of Obesity and Related Metabolic Disorders, 23 Suppl 2*, S2-S11.

Neumark-Sztainer, D., Story, M., Hannan, P. J., Perry, C. L., & Irving, L. M. (2002). Weight-related concerns and behaviors among overweight and nonoverweight adolescents: implications for preventing weight-related disorders. *Archives of Pediatrics and Adolescent Medicine, 156*(2), 171-178.

Neumark-Sztainer, D., Wall, M. M., Story, M., & Perry, C. L. (2003). Correlates of unhealthy weight-control behaviors among adolescents: implications for prevention programs. *Health Psychology, 22*(1), 88-98.

Nguyen, V. T., Larson, D. E., Johnson, R. K., & Goran, M. I. (1996). Fat intake and adiposity in children of lean and obese parents. *American Journal of Clinical Nutrition, 63*, 507-513.

Niemeier, H. M., Raynor, H. A., Lloyd-Richardson, E. E., Rogers, M. L., & Wing, R. R. (2006). Fast food consumption and breakfast skipping: predictors of weight gain from adolescence to adulthood in a nationally representative sample. *Journal of Adolescent Health, 39*(6), 842-849.

Obarzanek, E., Schreiber, G. B., Crawford, P. B., Goldman, S. R., Barrier, P. M., Frederick, M. M., & Lakatos, E. (1994). Energy intake and physical activity in relation to indexes of body fat: the National Heart, Lung, and Blood Institute Growth and Health Study. *American Journal of Clinical Nutrition, 60*, 15-22.

Patricia, M. C. M., Waijers, P. M., Feskens, E. J., & Ocke, M. C. (2007). A critical review of predefined diet quality scores. *Br J Nutr, 97*(2), 219-231.

Rampersaud, G. C., Pereira, M. A., Girard, B. L., Adams, J., & Metzl, J. D. (2005). Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *Journal of the American Dietetic Association, 105*(5), 743-760.

Ruvession, R., & Tataranni, P. A. (1997). Dietary fat and human obesity. *Journal of the American Dietetic Association, 97*, S42-S46.

Sanigorski, A. M., Bell, A. C., & Swinburn, B. A. (2007). Association of key foods and beverages with obesity in Australian schoolchildren. *Public Health Nutrition, 10*(2), 152-157.

Serdula, M. K., Ivery, D., Coates, R. J., Freedman, D. S., Williamson, D. F., & Byers, T. (1993). Do obese children become obese adults? A review of the literature. *Preventive Medicine, 22*(2), 167-177.

Shatenstein, B., Nadon, S., & Ferland, G. (2003). Diet quality among older Quebecers as assessed by simple indicators. *Can J Diet Pract Res, 64*(4), 174-180.

Shields, M. (2005). Measured obesity: Overweight Canadian children and adolescents [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/2005001/pdf/cobesity.pdf.

Strauss, R. S. (1999). Comparison of measured and self-reported weight and height in a cross-sectional sample of young adolescents. *International Journal of Obesity and Related Metabolic Disorders, 23*(8), 904-908.

Striegel-Moore, R. H., Thompson, D., Affenito, S. G., Franko, D. L., Obarzanek, E., Barton, B. A., Schreiber, G. B., Daniels, S. R., Schmidt, M., & Crawford, P. B. (2006). Correlates of beverage intake in adolescent girls: the National Heart, Lung, and Blood Institute Growth and Health Study. *Journal of Pediatrics, 148*(2), 183-187.

Supple, A. J., Aquilino, W. S., & Wright, D. L. (1999). Collecting sensitive self-report data with laptop computers: Impact on the response tendencies of adolescents in a home interview. *Journal of Research on Adolescence, 9*(4), 467-488.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate Statistics* (5th ed.). New York: Pearson Education, Inc.

Thompson, A. M., Campagna, P. D., Rehman, L. A., Murphy, R. J., Rasmussen, R. L., & Ness, G. W. (2005). Physical activity and body mass index in grade 3, 7, and 11 Nova Scotia students. *Medicine and Science in Sports and Exercise 37*(11), 1902-1908.

Troiano, R. P., Briefel, R. R., Carroll, M. D., & Bialostosky, K. (2000). Energy and fat intakes of children and adolescents in the United States: Data from the National Health and Nutrition Examination surveys. *American Journal of Clinical Nutrition, 72*(5 Suppl), 1343S-1353S.

Tucker, L. A., Seljaas, G. T., & Hager, R. L. (1997). Body fat percentage of children varies according to their diet composition. *Journal of the American Dietetic Association, 97*(9), 981-986.

Vartanian, L. R., Schwartz, M. B., & Brownell, K. D. (2007). Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *American Journal of Public Health, 97*(4), 667-675.

Veugelers, P. J., & Fitzgerald, A. L. (2005). Prevalence of and risk factors for childhood overweight and obesity. *Canadian Medical Association Journal, 173*(6), 607-613.

Whitaker, R. C., Wright, J. A., Pepe, M. S., Seidel, K. D., & Dietz, W. H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *The New England Journal of Medicine, 337*(13), 869-873.

World Health Organization. (2006). Obesity and overweight. *Fact sheets*, from http://www.who.int/mediacentre/factsheets/fs311/en/

World Health Organization. (2007). Obesity and overweight. *Chronic disease information sheets* Retrieved December 18, 2006, from http://www.who.int/dietphysicalactivity/publications/facts/obesity/en/

Chapter 8: Conclusions and Discussion

8.1 Review of Hypotheses and Conclusions

Hypothesis 1: In a sample of Canadian adolescents:

- **a.** Acceptable Macronutrient Distribution Ranges will be consistent with recommendations **(Chapter 4, 6)**.
- **b.** fibre and adjusted average intakes of key micronutrients* will be inconsistent with recommendations **(Chapter 4, 6).**
- **c.** median food group intakes will be below recommendations **(Chapter 4, 6).**
- **d.** boys will have higher energy, macronutrient and food group intakes than girls **(Chapter 4, 6).**

Hypothesis 1a was accepted as both boys and girls had macronutrient intakes within the Acceptable Macronutrient Distribution Ranges (AMDRs). Although observed intakes were within the AMDR for all macronutrients, over one-third of students were above the recommendation for percent of energy from fat. Further, these values are ranges of the distribution of the diet and not absolute values. **Hypothesis 1b** was accepted because intakes of iron, niacin, zinc, calcium, vitamin D and fibre were inconsistent with recommendations. Intakes of vitamin A compared to recommendations could not be determined due to the extreme variation in daily intake of this nutrient (Institute of Medicine, 2000a). Nutrients of greatest concern were iron, zinc, calcium and fibre where the percentage of students below the EAR indicated that over one-third of the sample were at risk of inadequacy, or observed intakes were well below the AI. Prevalence of inadequacy could not be determined for nutrients with an AI, as many values below the AI are likely to be adequate (Institute of Medicine, 2000b). Further, older boys and girls (14 to 17 years) had a greater risk of inadequacy compared to younger boys and girls (9 to 13 years). **Hypothesis 1c** was verified for all Canada's Food Guide to Healthy Eating (CFGHE) food groups for girls and for Vegetables and Fruit and Milk Products for boys. Girls' median intakes for all food groups were below the CFGHE recommendations. Boys' median intakes for Vegetables and Fruit (Chapter 6 only) and Milk Products were below the CFGHE recommendations. With the exception of percent of energy from carbohydrate, boys had higher intakes of energy, macronutrients and food groups than girls, therefore, **Hypothesis 1d** was also accepted. Although CFGHE was recently revised and replaced with Eating Well with Canada's Food Guide (Health Canada, 2007), the 1992 CFGHE was the government recommendation during data collection and was also a component of Alberta (Alberta Learning, 2002, 2005) and Ontario (Ontario Ministry of Education, 2000, 2005) school curricula. Therefore, it was most appropriate to compare intakes to the 1992 CFGHE recommendations.

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*Vitamin A, vitamin C, iron, niacin, zinc, calcium, vitamin D (key micronutrients for optimal nutritional intakes)

Hypothesis 2: Using a measure of diet quality[†] based on Canada's Food Guide to Healthy Eating, Canadian adolescents with average or superior diet quality, compared to those with poor diet quality will have:

[†] Diet Quality: poor, met 0-1 food group recommendations; average, met 2-3 food group recommendations; superior, met all four food group recommendations.

a. significantly different macronutrient intakes, where those with average or superior diet quality will have higher intakes of fibre and lower intakes of fat compared to those with poor diet quality **(Chapter 4, 6)**.

b. significantly lower intakes of foods from the Other Foods sub-categories **(Chapter 4, 6)**.

c. significantly lower frequency of sub-optimal meal behaviours including meal skipping and consuming meals away from home **(Chapter 4, 6)**.

d. significantly higher levels of physical activity **(Chapter 6).**

Hypothesis 2a was accepted, where those with both average and superior diet quality had higher intakes of protein and fibre and lower intakes of carbohydrates (Chapter 6 only) and fat when compared to those with poor diet quality. Further, those with superior diet quality had higher intakes of protein and fibre and lower intakes of fat compared to those with average diet quality, which suggests a step-wise improvement in nutrition when diet quality increased from poor to average to superior. With the exception of low calorie beverages, **Hypothesis 2b** was accepted as those with superior diet quality had lower intakes of Other Foods sub-categories (mostly sugar, high salt/fat, high calorie beverages, high sugar/fat) compared to those with poor diet quality. Differences existed between average and poor diet quality groups (mostly sugar (Chapter 6 only), high salt/fat, high calorie beverages, high sugar/fat), and between superior and average diet quality groups (high salt/fat, high calorie beverages, high sugar/fat (Chapter

4 only)), where intakes of these foods decreased with improvements in diet quality. **Hypothesis 2c** was accepted for the majority of the sub-optimal meal behaviours including frequency of breakfast and lunch (Chapter 4 only), and consumption of meals and snacks at the following locations: school cafeteria, fast food/take out, other restaurants, vending machines, snack bars, and convenience stores. Students with both average and superior diet quality had a lower frequency of skipping breakfast and lunch (Chapter 4 only), and a lower frequency of consuming meals or snacks away from home (school cafeteria (difference between average and poor diet quality was only observed in Chapter 6), fast food/take out, other restaurant, vending machines, snack bars and convenience stores) compared to students with poor diet quality. Significant differences existed between all three diet quality groups for consuming meals or snacks at fast food/take out locations and vending machines for both Chapter 4 and Chapter 6, while significant differences existed between all three diet quality groups for consuming meals or snacks at other restaurants, snack bars and convenience stores for Chapter 6. **Hypothesis 2d** was accepted as those with both average and superior diet quality had higher levels of physical activity compared to those with poor diet quality. In addition, students with superior diet quality had higher levels of physical activity compared to their peers with average diet quality.

Hypothesis 3: In a sample of Alberta junior and senior high school students:

a. the majority of students will have low levels of physical activity **(Chapter 6)**.

b. girls will have lower levels of physical activity than boys **(Chapter 6)**.

c. older students will have lower levels of physical activity than younger students **(Chapter 6)**.

Hypothesis 3a was verified, where more than half of students (57%) had physical activity levels below a score of three (moderate activity). Further, **Hypothesis 3b** and **Hypothesis 3c** were both accepted where girls had lower levels of physical activity than boys, and older students (14 or greater years of age) had lower levels of physical activity than younger students (13 or less years of age).

Hypothesis 4: In a sample of Alberta junior and senior high school students, non-overweight[‡] students compared to overweight or obese students will have:

a. significantly different macronutrient intakes **(Chapter 7)**.

b. significantly lower intakes of foods from the Other Foods sub-categories **(Chapter 7)**.

c. significantly higher diet quality[†] as based on Canada's Food Guide to Healthy Eating **(Chapter 7)**.

d. significantly lower frequency of sub-optimal meal behaviours including meal skipping and consuming meals away from home **(Chapter 7)**.

[‡] Non-overweight refers to all non-overweight, non-obese students

[†] Diet Quality: poor, met 0-1 food group recommendations; average, met 1-3 food group recommendations; superior, met all four food group recommendations.

Hypothesis 4a was accepted (with exception to protein intakes) as non-overweight students compared to both overweight and obese students had significantly higher intakes of carbohydrates and fibre and significantly lower intakes of fat. Differences did not exist between overweight and obese students or for protein intakes. **Hypothesis 4b** was rejected as non-overweight students did not have significantly different intakes of Other Foods sub-categories compared to their overweight or obese peers. However, significance was observed for high calorie beverage intake based on univariate analysis, where non-overweight students consumed significantly less high calorie beverages compared to obese students. **Hypothesis 4c** was rejected; there was no difference between BMI classification and diet quality. Although differences were not observed between BMI classification and diet quality, significance was observed at the macronutrient level. Non-overweight students had significantly higher intakes of fibre and carbohydrates and significantly lower intake of fat compared to both overweight and obese students. Consumption of CFGHE foods is reflected in macronutrient intakes, such that higher intakes of fat may be reflective of high Other Food consumption. Further, very few students in the entire sample had superior diet quality. This suggests that overall diet quality may be a more important indicator of nutrition, and supports the need to target all adolescents, not only those that are overweight or obese. The meal skipping component of **Hypothesis 4d** was accepted, while the consumption of meals or snacks away from home component of **Hypothesis 4d** was rejected. While non-overweight students had a higher frequency of consuming breakfast and snacks compared to obese students, no differences were observed for consumption of meals or snacks away from home. In the current study, the frequency of family meals was not examined. Family meals may have been a better indicator of BMI classification than consumption of meals away from home at independent locations

Hypothesis 5: In a sample of Alberta junior and senior high school students, non-overweight[‡] students compared to overweight or obese students will have higher levels of physical activity **(Chapter 7).**

a. Non-overweight boys will have higher levels of physical activity than overweight or obese boys **(Chapter 7).**

b. Non-overweight girls will have higher levels of physical activity than overweight or obese girls **(Chapter 7).**

Hypothesis 5 was accepted as non-overweight and overweight students were more active than obese students. Further, **Hypothesis 5a** and **Hypothesis 5b** were both accepted where non-overweight and overweight boys were more active than obese boys, and non-overweight girls were more active than obese girls.

8.2 Discussion

The major findings of this thesis outline a number of health concerns of Canadian adolescents. While most adolescents are meeting the recommendations for macronutrients in terms of the distribution of energy, many adolescents are not meeting minimum recommendations as established by the Institute of Medicine for micronutrients and CFGHE, and thus have poor diet quality. Further, students with poor diet quality were more likely to have sub-optimal nutritional intakes and meal behaviours and low levels of physical activity. These behaviours are also of concern due to their role as determinants of obesity in the adolescent population. Understanding differences between non-overweight and overweight or obese students in terms of specific behaviours such as nutrient intakes, meal behaviours and physical activity are important research initiatives due to the high prevalence of overweight and obesity in Canada.

[‡] Non-overweight refers to all non-overweight, non-obese students

Although national surveys have indicated that Canadian adolescents have sub-optimal nutritional intakes and low levels of physical activity (Garriguet, 2004; Shields, 2005), less is know about the overall diet quality of this population based on adherence to recommendations established by CFGHE. Although each food group is individually important, total health and wellness relies on the appropriate balance and variety of all four food groups (Health Canada, 1992) as well as adequate levels of physical activity (Health Canada and the Canadian Society for Exercise Physiology, 2002). Further, the relationships between diet quality and BMI classification with nutrient intakes, meal behaviours and physical activity are not well understood as many surveys that assessed these health behaviours did not do so simultaneously or were limited by a small sample size. Given the significant long-term health and economic implications of adolescent obesity, research in the area of obesity determinants has become increasingly important. Specifically, individual behaviours such as poor nutritional intakes and decreased physical activity have been identified as key determinants which have contributed to dramatic increases in prevalence of overweight and obesity over the past 25 years (Raine, 2004; Shields, 2005).

Because adolescents are at a life stage where they have increased autonomy regarding health behaviours, many of the decisions and choices adolescents make may persist into adulthood and have lasting impact on long term health (Dietz, 1998). Therefore, the purpose of this thesis was to assess the overall diet quality and overweight/obesity status of a sample of Canadian adolescents, and evaluate the relationship between diet quality and BMI classification with nutrient intakes, meal behaviours, and physical activity levels in order to help provide important information for the development of programs to improve the health and well-being of the adolescent population.

Although variables in this thesis were assessed using self-report, the novel web-based method of surveillance provided a unique opportunity to survey a large number of participants concurrently throughout a wide geographic area. Access to hard-to-reach areas was enhanced, which improved the ability to obtain a representative sample (Eaton & Struthers, 2002). Further, adolescents were familiar with computer and internet technology, especially in Alberta where the SuperNet was implemented in 2002, which provides high-speed internet service to thousands of facilities (government offices, schools, health care facilities, libraries) in 429 communities throughout the province (Government of Alberta, 2002). Utilizing a web-based method of data collection also helped to reduce errors and bias. Web-based surveys eliminate interviewer bias by standardizing the interaction a participant has with the survey. Data entry errors were also non-existent, as the web-based methodology utilized a database electronically linked to our surveys, which eliminated the need for manual data entry (Rhodes, Bowie, & Hergenrather, 2003). Web-surveys have also been shown to increase the reporting of sensitive behaviours in adolescents (Webb, Zimet, Fortenberry, & Blythe, 1999). Web-surveys provide anonymity and privacy which other methods (such as face-to-face interviewing) do not allow. Although nutrition and physical activity behaviours are generally not thought of as sensitive behaviours, many adolescents have perceptions of socially desirable answers in regards to these behaviours (Brener, Billy, & Grady, 2003). It has been shown that anonymity and privacy are important determinants when adolescents choose to report honest answers (Ginsburg et al., 1995; Supple, Aquilino, & Wright, 1999). Reactivity was also decreased because students were not aware in advance what day the survey was to be completed. Furthermore, anonymity and privacy were extremely important when conducting this research in schools, as many school administrators required the survey to be anonymous. The validation of various components of the web-based survey (Chapter 5) makes this tool an attractive, efficient and cost-effective method of data collection (Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997; Hanning & Health Behaviour Research Group, 2004; Hanning et al., 2004; Kowalski, Crocker, & Faulkner, 1997).

In summary, this research supports the current literature that indicates that overweight/obesity is prevalent in the adolescent population and that many adolescents have sub-optimal health behaviours including poor nutritional intakes and low levels of physical activity. Although obesity is often associated with over-nutrition, results from the present research suggest that many overweight and obese adolescents may also be at risk for nutrient inadequacy. In addition, adolescents in this study also had low levels of physical activity. Although nutrient requirements increase with age, older adolescents (14 to 17 years) had similar intakes compared to their younger peers (9 to 13 years); in addition older adolescents also had lower levels of physical activity. This suggests an overall decrease in total health and wellness among older adolescents, where older adolescents are not meeting their increased physiological requirements for both nutrition and physical activity.

Given the low adherence to CFGHE, it is not surprising that the majority of students in the present research had either poor or average diet quality in addition to low intakes of micronutrients. Due to the observed high intakes of Other Foods, it is likely that students were compensating for low CFGHE intakes with Other Foods, which concurrently resulted in low micronutrient intakes. Adherence to CFGHE could result in higher intakes of fibre and lower intakes of total fat and Other Foods. However, adherence to CFGHE may not be sufficient to meet the fibre recommendations established by the Institute of Medicine (DRI). Regular meal consumption, especially breakfast, may also be an important determinant of an adolescent's ability to meet CFGHE and DRI recommendations as well as an optimal BMI classification. Although intakes were compared to the 1992 CFGHE, it is expected that if intakes were compared to the new food guide, Eating Well with Canada's Food Guide, even fewer students would be meeting minimum recommendations, especially for Vegetables and Fruit and Grain Products. The new food guide includes specific recommendations for individuals within different life stage and gender groups, thus minimum recommendations for adolescents are higher than previously recommended.

Fast food consumption has been previously associated with higher percent of energy from fat, daily servings of soft drinks, and lower intakes of fruit, vegetables and milk (French, Story, Neumark-Sztainer, Fulkerson, & Hannan, 2001) and supports the findings of the present research. In addition, consumption of meals and snacks at any location away from home (not only fast food restaurants) may result in lower diet quality and sub-optimal nutritional intakes and therefore should be examined more broadly to include all locations away from home.

Behaviours established during adolescence have been shown to track into adulthood, therefore it is important to address these behaviours during early adolescence. Targeting sub-optimal behaviours such as high intakes of Other Foods sub-categories, especially high calorie beverages, consumption of meals and snacks away from home, and physical inactivity may be important steps to improve overall diet quality and weight status in the adolescent population.

8.3 Future Research Directions

This thesis has provided evidence for the need to improve overall nutrition, physical activity and related health behaviours in Canadian adolescents, particularly older adolescents. Future research initiatives that target specific behaviours as described in the overall discussion and conclusion of this thesis are important research directions that warrant further investigation.

- In this thesis, although differences in macronutrient intakes were observed between BMI classifications, no differences were observed in diet quality among non-overweight, overweight and obese students. Further, the classification of overweight or obesity did not necessarily indicate an adequate intake of macronutrients and CFGHE foods. Low intakes of CFGHE foods and high intakes of Other Foods sub-categories suggest that students are replacing CFGHE foods with Other Foods independent of BMI classification. Therefore, interventions that target all adolescents, not just those that are overweight or obese, are important steps towards improving the total health and wellness of this population.

- Interventions that target high calorie beverage consumption, breakfast skipping, consumption of meals or snacks away from home, and physical inactivity may improve total diet quality and weight status. The removal of vending machines in schools, mandatory daily physical activity and school breakfast programs are some examples of initiatives that could be extended to all school-age youth, and are particularly important in late adolescence. These behaviours should be targeted in early adolescence in order to help prevent these behaviours from tracking into later adolescence and adulthood.

- Continuous surveillance of this population is necessary in order to monitor changes in weight status, nutrition and physical activity over time. The web-based tool used in this thesis provides researchers with the capability to survey a large number of participants simultaneously throughout a wide geographic area. Multiple collection periods, over time, would provide invaluable data in order to guide and develop nutrition and physical activity interventions and policy.

- Schools are an accessible medium that allows surveillance of a representative sample of adolescents throughout Canada. Partnerships that facilitate surveillance and streamline the approval process would benefit researchers, administrators, schools, parents and students.

- The web-based tool could be easily adapted to investigate populations (including adults) at-risk for numerous health consequences including obesity and type 2 diabetes. For example, Aboriginal populations, individuals with low socioeconomic status or those living in rural communities could be specifically targeted using the web-based method of surveillance.

8.4 References

Alberta Learning. (2002). Health and life skills, kindergarten to grade 9 [Electronic Version]. Retrieved December 7, 2006 from http://www.education.gov.ab.ca/k_12/curriculum/bySubject/healthpls/health.pdf.

Alberta Learning. (2005). Career and technology studies [Electronic Version]. Retrieved December 7, 2006 from http://www.education.gov.ab.ca/k%5F12/curriculum/bySubject/cts/foods/fodpos.pdf.

Brener, N. D., Billy, J. O. G., & Grady, W. R. (2003). Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *Journal of Adolescent Health, 33*(6), 436-457.

Crocker, P. R. E., Bailey, D. A., Faulkner, R. A., Kowalski, K. C., & McGrath, R. (1997). Measuring general levels of physical activity: preliminary evidence for the Physical Activity Questionnaire for Older Children. *Medicine and Science in Sports and Exercise, 29*(10), 1344-1349.

Dietz, W. H. (1998). Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics, 101*(3), 518-525.

Eaton, J., & Struthers, C. W. (2002). Using the internet for organizational research: a study of cynicism in the workplace. *CyberPsychology and Behavior, 5*(4), 305-313.

French, S. A., Story, M., Neumark-Sztainer, D., Fulkerson, J. A., & Hannan, P. (2001). Fast food restaurant use among adolescents: associations with nutrient intake, food choices and behavioral and psychosocial variables. *International Journal of Obesity and Related Metabolic Disorders, 25*(12), 1823-1833.

Garriguet, D. (2004). Overview of Canadians' eating habits [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/82-620-MIE2006002.pdf.

Ginsburg, K. R., Slap, G. B., Cnaan, A., Forke, C. M., Balsley, C. M., & Rouselle, D. M. (1995). Adolescents' perceptions of factors affecting their decisions to seek health care. *Journal of the American Medical Association, 273*(24), 1913-1918.

Government of Alberta. (2002). Alberta SuperNet. Retrieved December 10, 2006, from http://www.albertasupernet.ca/

Hanning, R., & Health Behaviour Research Group. (2004). University of Waterloo: Food Behaviour Survey.

Hanning, R., Lambraki, I., MacDonald, C., McCargar, L., Health Behaviour Research Group, & Beyond an Apple a Day Research Group. (2004). *A web-based approach to nutritional assessment in schools.* Paper presented at the International Congress of Dietetics, Chicago, Illinois.

Health Canada. (1992). Canada's Food Guide to Healthy Eating [Electronic Version]. Retrieved December 7, 2006 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/fg_rainbow-arc_en_ciel_ga_e.pdf.

Health Canada. (2007). Eating Well with Canada's Food Guide [Electronic Version]. Retrieved February 8, 2007 from http://www.hc-sc.gc.ca/fn-an/alt_formats/hpfb-dgpsa/pdf/food-guide-aliment/view_eatwell_vue_bienmang_e.pdf.

Health Canada and the Canadian Society for Exercise Physiology. (2002). Canada's Physical Activity Guide for Youth [Electronic Version]. Retrieved December 7, 2006 from http://www.phac-aspc.gc.ca/pau-uap/paguide/child_youth/pdf/guide_y_en.pdf.

Institute of Medicine. (2000a). *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc.* Washington: National Academy Press.

Institute of Medicine. (2000b). Dietary Reference Intakes: Applications in Dietary Assessment. Washington: National Academy Press.

Kowalski, K. C., Crocker, P. R. E., & Faulkner, R. A. (1997). Validation of the Physical Activity Questionnaire for Older Children. *Pediatric Exercise Science, 9*, 174-186.

Ontario Ministry of Education. (2000). The Ontario curriculum, grades 11-12, Health and physical education [Electronic Version]. Retrieved December 7, 2006 from http://www.edu.gov.on.ca/eng/curriculum/secondary/health1112curr.pdf.

Ontario Ministry of Education. (2005). The Ontario curriculum, grades 1-8, Health and physical education [Electronic Version]. Retrieved December 7, 2006 from http://www.edu.gov.on.ca/eng/curriculum/elementary/health18curr.pdf.

Raine, K. D. (2004). Overweight and obesity in Canada: A population health perspective [Electronic Version]. *Canadian Population Health Initiative*, 1-81 from http://www.cihi.ca/cihiweb/dispPage.jsp?cw_page=GR_1130_E.

Rhodes, S. D., Bowie, D. A., & Hergenrather, K. C. (2003). Collecting behavioural data using the world wide web: considerations for researchers. *Journal of Epidemiology and Community Health, 57*(1), 68-73.

Shields, M. (2005). Measured obesity: Overweight Canadian children and adolescents [Electronic Version] from http://www.statcan.ca/english/research/82-620-MIE/2005001/pdf/cobesity.pdf.

Supple, A. J., Aquilino, W. S., & Wright, D. L. (1999). Collecting sensitive self-report data with laptop computers: Impact on the response tendencies of adolescents in a home interview. *Journal of Research on Adolescence, 9*(4), 467-488.

Webb, P. M., Zimet, G. D., Fortenberry, J. D., & Blythe, M. J. (1999). Comparability of a computer-assisted versus written method for collecting health behavior information from adolescent patients. *Journal of Adolescent Health, 24*(6), 383-388.

Appendices

Appendix A: Web-Survey I Information Package

1. **Information Letter for Board Recruitment**
2. **Information Letter for Private School Recruitment**
3. **Information Letter for School Recruitment**
4. **Letter and Information Package for Teachers**
5. **Web-Survey Summary**
6. **Parent Information Letter**
7. **Student Information Letter (Grades Nine and Ten)**
8. **Consent Form**
9. **Student Assent Form**

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INFORMATION LETTER for Board Recruitment

[Date]

Dear [Name]:

We would like to invite the [Board Name] to participate in a new study examining food and activity behaviours in Alberta youth. This research will investigate the nutrition and physical activity choices of students in grades seven through ten by using a web-based survey. Each student will receive individual feedback immediately upon completion of the computer-based survey.

Alberta Learning is in support of this important research and participates in the Advisory Committee for the project design and implementation. This web-based survey complements the Comprehensive School Health Model and new curriculum. Class group data will be provided to the teacher, with suggestions on how to incorporate the feedback into the grade-specific curriculum and relevant learning resources.

As you know, students in grades seven through ten experience many physiological and psychological milestones, including the adolescent growth spurt with rapid bone development, and increasing autonomy in food behaviours. There is little information on the diet of Alberta youth, however dietary surveys elsewhere indicate that children and teens consume insufficient amounts of energy, calcium, iron, and may have low levels of physical activity. Obesity is particularly concerning, as many overweight and obese children become obese adults, at risk for diabetes and heart disease. Thus the diets of Alberta youth are of tremendous interest.

The web-based tool was developed by Dr. Rhona Hanning at the University of Waterloo, and has been used to survey Ontario students. We will survey a large, regionally diverse sample of Alberta youth, creating the most comprehensive assessment of Alberta youth's diet and physical activity. Your board and schools within your board have been randomly selected to participate in this survey. Please find attached copies of the following: 1) a summary of the project with details on the design, objectives and measures to be used for this study, 2) the survey questions, 3) the information letter and consent form that will be sent to parents, and 4) the information letter for the students.

The following schools from within your board were selected: [School Names]. In the event an insufficient number of schools from your board can participate, we have selected back-up schools, which may be required in order to complete the research survey. These schools have been selected as back-up schools: [School Names].

This study has been reviewed by, and received ethics clearance from the Human Research Ethics Review Board in the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta. The research survey for grades seven and eight is part of the Alberta Healthy Schools Initiative: Beyond an Apple a Day Project funded by Health Canada, and coordinated by Alberta Milk. The Initiative is a collaborative project that involves Alberta Health and Wellness, Alberta Learning, Everactive Schools, and the University of Alberta. The research survey for grades nine and ten is funded by the Beef Information Centre.

We would like an opportunity to speak with you to discuss our project and [Board Name]'s protocol for the approval of research projects. We appreciate the strain on school boards and schools at this time and do not wish to create more pressure. If there is anything we can do to make it easy for your schools to participate, please let us know. One of our staff will call you during the week of [Week] to determine your interest. In the meantime, if you have any questions, please call either Kate Calengor or Kendall Taft at 492-3700 or by e-mail at either calengor@ualberta.ca or ktaft@ualberta.ca. We look forward to further collaboration with you on this exciting project.

Sincerely,

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Dept of Agricultural, Food
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Kendall Taft, MSc Candidate
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INFORMATION LETTER for Recruitment

[Date]

Dear [Name]:

We would like to invite [Authority Name] to participate in a new study examining food and activity behaviours in Alberta youth. This research will investigate the nutrition and physical activity choices of students in grades nine and ten by using a web-based survey. Each student will receive individual feedback immediately upon completion of the computer-based survey.

Alberta Learning is in support of this important research and participates in the Advisory Committee for the project design and implementation. This web-based survey complements the Comprehensive School Health Model and new curriculum. Class group data will be provided to the teacher, with suggestions on how to incorporate the feedback into the grade-specific curriculum and relevant learning resources.

As you know, students in grades nine and ten experience many physiological and psychological milestones, including the adolescent growth spurt with rapid bone development, and increasing autonomy in food behaviours. There is little information on the diet of Alberta youth, however dietary surveys elsewhere indicate that children and teens consume insufficient amounts of energy, calcium, iron, and may have low levels of physical activity. Obesity is particularly concerning, as many overweight and obese children become obese adults, at risk for diabetes and heart disease. Thus the diets of Alberta youth are of tremendous interest.

The web-based tool was developed by Dr. Rhona Hanning at the University of Waterloo, and has been used to survey Ontario students. We will survey a large, regionally diverse sample of Alberta youth, creating the most comprehensive assessment of Alberta youth's diet and physical activity. Your school has been randomly selected to participate in this survey. Please find attached copies of the following: 1) a summary of the project with details on the design, objectives and measures to be used for this study, 2) the survey questions, 3) the information letter and consent form that will be sent to parents, and 4) the information letter for the students.

This study has been reviewed by, and received ethics clearance from the Human Research Ethics Review Board in the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta. The research survey is funded by the Beef Information Centre.

We would like an opportunity to speak with you to discuss our project and [Authority Name]'s protocol for the approval of research projects. We appreciate the strain on schools at this time and do not wish to create more pressure. If there is anything we can do to make it easy for your school to participate, please let us know. One of our staff will call you during the week of [Week] to determine your interest. In the meantime, if you have any questions, please call Kate Calengor at 492-3700 or by e-mail at calengor@ualberta.ca. We look forward to further collaboration with you on this exciting project.

Sincerely,

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INFORMATION LETTER for School Recruitment

[Date]

Dear [Name]:

The University of Alberta has the approval of your school board to invite [school name] to participate in a new study examining food and activity behaviours in Alberta youth. The research will investigate the nutrition and activity choices of students in grades nine and ten using a web-based survey.

Alberta Learning is in support of this important research and participates in the Advisory Committee for the project design and implementation. This web-based survey complements the Comprehensive School Health Model and new curriculum. Feedback from the survey will be available to the individual students, and teachers will receive group feedback and suggestions for incorporating the results into the curriculum, including relevant learning resources.

As you know, students in grades nine and ten experience many physiological and psychological milestones, including the adolescent growth spurt with rapid bone development, and increasing autonomy in food behaviours. There is little information on the diet of Alberta youth, however dietary surveys elsewhere indicate that children and teens consume insufficient amounts of energy, calcium, iron, and may have low levels of physical activity. These have the potential to exert a strong deleterious impact on future health and increase the risk of chronic disease in later life. Through better understanding of the eating patterns of Alberta youth, and variables that influence this pattern, targeted healthy eating programs and strategies can be designed.

The web-based tool was developed by Dr. Rhona Hanning at the University of Waterloo and has been used to survey Ontario students. We will survey a large, regionally diverse sample of Alberta youth, creating the most comprehensive assessment of Alberta youth's diet and physical activity. Your school has been randomly selected to participate in this survey. Please find attached copies of the following: 1) a summary of the project with details on the design, objectives and measures to be used for this study, 2) the survey questions, 3) the information letter and consent form that will be sent to parents, and 4) the information letter for the students. Upon your approval of this research study, we would ask you to randomly select two classrooms (if possible) to participate in the nutrition and physical activity survey.

The research has been reviewed by and received ethics clearance from the Human Research Ethics Review Board at the University of Alberta. This research is funded by the Beef Information Centre.

We would like an opportunity to speak with you to discuss this project and the possibility of your school's participation. We appreciate the strain on schools at this time and do not wish to create more pressure. If there is anything we can do to make it easy for your school to participate, please let us know. One of our staff will call you during the week of [Week] to determine your interest. In the meantime, if you have any questions, please call Kate Calengor at (780) 492-3700, calengor@ualberta.ca. We look forward to further collaboration with you on this exciting project.

Sincerely,

Kate Calengor, MSc Candidate
Study Coordinator,
Dept of Agricultural, Food
& Nutritional Science
University of Alberta
Phone: 780-492-3700

Linda McCargar, PhD, RD
Professor,
Dept of Agricultural, Food
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Rhona Hanning, PhD, RD
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Letter and information package for teachers

[Date]

[School Address]

Dear [Name]:

Thank you for agreeing to participate in the "Web-Based Nutrition and Physical Activity Survey, part of the Alberta Healthy Schools Initiative: Beyond an Apple a Day Project". The contribution that you and the students in your school will make is invaluable. The information gathered from this project may be used to develop nutrition and healthy lifestyle education programs targeting "risk" behaviours or at-risk populations. By identifying the factors that are associated with "risk" behaviours, we hope to indicate potential areas for preventive programs, and reduce the health and economic burdens associated with poor nutrition and low physical activity. Data may also be used to compare food consumption across populations, provinces and even internationally.

Preparing for the Survey:

This web-based survey complements the Comprehensive School Health Model and new curriculum and may be directly incorporated into Health, Science, Math, Physical Education, or Computer classes. The survey can be implemented during any class period.

If there are sufficient computer facilities, it would be most efficient for all of your students to complete the survey simultaneously. Otherwise students may complete the survey as an independent activity or however you deem appropriate. It is expected that students will require approximately one class period to complete the survey.

A package addressed to Kate Calengor, and containing parental information letters and consent forms is included with this mailing. We are asking your school to either address the stamped envelopes containing the parental information letter, and mail them to all parents of potential participants in grades nine or ten, or have the students take the letter and consent form home to parents. To encourage students to return their parental consent forms, each student who returns a completed consent form (whether their parent consented to participation or not), will be entered to win a prize. There will be one prize offered per class. You will also have received a package containing student information letters. Please distribute these to students in your class.

Participation in the study is voluntary, and the decision to participate is made by each student and his or her parents. If parents do not sign and return the consent forms to the teachers, students cannot participate in the survey.

Logins and passwords will be provided to you to access the survey once the signed consent forms have been returned to the University of Alberta. Randomly distribute these to each student who is participating, on the day of the survey. If you require more logins and passwords than are supplied, please contact Kate Calengor at (780) 492-3700. Please keep a record of the assigned logins and passwords on the sheet provided, noting those logins and passwords that were not assigned. To sustain anonymity, please do not include the students' names with their logins and passwords. If a student chooses to withdraw please note that on the same sheet.

One of our nutrition research assistants working on this project will be accessible by phone during the time that your class is completing the survey.

Completing the Survey

The survey is located at http://eatwell.igsol.com. The web site is best viewed using Internet Explorer, but any web browser will suffice.

The survey is available for teachers to visit before students input their food records.
Your login name is: s
Your password is: s

Students are able to complete the survey independently. It is important to note that:

- The survey is confidential and anonymous. Students' names are not on the survey. Every participant has a unique identification and password; only the researchers at the University of Waterloo will see their answers. No one at the school will know students' answers.
- We would like to know what students ate ***yesterday***. We would like them to remember as much as possible.
- Surveys should only be done Tuesday through Friday to obtain weekday food intake. If Monday is a holiday, then surveys should only be done Wednesday through Friday.
- Surveys must be completed between the hours of 7 a.m. to 3 p.m. in order for technical support to be available.
- We have tried to include as many foods as possible, but we have not been able to include **every** food. Please ask the students to choose a food item that most closely resembles what he/she ate. If in doubt, please call the researcher on call during the survey period.
- The web site is available should students want to repeat the survey on a different day. This is of course optional, and would be done on the student's own time.
- Students may complete the survey only once each day. Twenty-four hours needs to lapse before students can input more data.

- Students should store their logins/password cards in a safe place. Students must remember their logins and passwords if they wish to return on another day to complete the survey.
- Participation in the survey is completely voluntary.

Directions for Accessing the Food Behaviour Questionnaire:

1. Open the Internet browser on your computer (Explorer or Netscape).
2. On the address line, enter the address: http://eatwell.igsol.com
3. Enter assigned login identification code.
4. Enter assigned password, hit the launch button.
5. The survey is open and ready to go. Follow the directions on the screen.

Your feedback regarding this survey is invaluable. We would appreciate your time in completing an online evaluation form using a login name and password that we will provide you on the day of the survey. However, if the online evaluation is not completed, a one-page question sheet will be faxed to you after the survey to obtain your feedback.

If you have any questions or concerns, please contact Kate Calengor at (780) 492-3700. A nutrition research assistant involved in this project will be available by phone on the day(s) that your school completes the survey. If you experience any technical difficulties with the web contact Clint MacDonald at (519) 576-1644 (Eastern Time). If he is not available at the previous number, you may contact him on his cell phone at (519) 841-0447.

Thank you for your participation in the project, we look forward to sharing the results with you.

Sincerely,

Study Coordinator
Kate Calengor, (780) 492-3700

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WEB-BASED NUTRITION AND PHYSICAL ACTIVITY SURVEY, PART OF THE ALBERTA HEALTHY SCHOOLS INITIATIVE: BEYOND AN APPLE A DAY PROGRAM

The purpose of the project is to examine food behaviour and physical activity patterns in Alberta adolescents using an Internet-based 24-hour diet recall in conjunction with a food behaviour and physical activity questionnaire.

WHY A SCHOOL SURVEY?

- Nutritional problems in youth have the potential to exert a deleterious impact on future health and increase the risk of chronic disease in later life.
- Results from small research studies in Canada and the U.S. suggest that children and adolescents are not consuming adequate amounts of meat and meat alternates and subsequently, iron and zinc intakes (especially in females) are low to marginal.
- The same studies suggest that young Canadians are not consuming the number of servings of milk and dairy products recommended by Canada's Food Guide to Healthy Eating. Hence, calcium intakes are not being met during a time of bone growth.
- Children and teens are also not meeting the minimum requirements for vegetables & fruit consumption and some related nutrients, like folate, may be low.
- Previous studies have not looked at some of the factors associated with youths' food consumption that may be important in designing relevant educational materials.
- School-based surveys are an effective way to collect information about this age group.

WHY USE THE INTERNET?

- The ability to provide immediate feedback to participants regarding their food behaviour.
- An interactive tool that is fun and easy for participants to use.
- The flexibility and universality of the Internet allows a large number of participants to complete the survey concurrently, in many different locations.

WHO IS INVOLVED IN THE PROJECT?

- The project is being conducted by Dr. Linda McCargar, Professor, Department of Agricultural, Food & Nutritional Sciences, of the University of Alberta, and by Dr. Rhona Hanning, a Principal Investigator with the Health Behaviour Research Group (HBR), and Associate Professor, Department of Health Studies and Gerontology, University of Waterloo. Drs. McCargar and Hanning are experts in the fields of nutrition. HBR has over 20 years of experience in conducting school-based surveys during which time over 120,000 students have participated. Dr. Dru Marshall, Assistant Dean, and Dr. John Spence, Assistant Professor, both members of the Faculty of Physical Education and Recreation, University of Alberta are co-investigators of this study.
- Kate Calengor is the study coordinator. Kate is a graduate student in Nutrition at the University of Alberta. The study coordinator will be accessible by phone during the time period that each class is completing the Internet survey.
- Participants will come from grades nine and ten from schools across Alberta.
- The research survey is funded by the Beef Information Centre.

WHAT IS INVOLVED FOR PARTICIPATING SCHOOLS?

- Teachers of students in grades nine and ten will be asked to facilitate the completion of the "Food Behaviour and Physical Activity Questionnaire".
- Completing the survey requires approximately one class period and may be incorporated into a Mathematics, Health and Physical Education, or Computer Usage class.
- Surveys should only be done Tuesday through Friday to obtain weekday food intake. Students are asked to recall their previous day's food intake. If Monday is a holiday, then surveys should only be done Wednesday through Friday.
- All participating students will be entered into regional draws to win gift certificates for music or video stores, and classes with participating students will be entered into provincial draws to win gift certificates for class materials or books.
- Upon completing the initial survey at school, students may go back to the web site on another day, where another set of questions about their eating habits will be available. This second portion of the project is optional.
- Teachers will receive group feedback and suggestions for incorporating the information into the grade-specific curriculum, and relevant learning resources.

CONSENT AND CONFIDENTIALITY MEASURES

- Information letters and consent forms will be provided to be sent home to parents. All students who return their parental consent forms (whether the parent consented to participation or not) will be entered to win a prize.
- Parents must complete, sign and return a consent form before their child can participate in the survey.
- The survey is anonymous.
- All students will have a unique identification code and password; unauthorized users will not have access to the survey.

WHAT ARE THE BENEFITS TO THE STUDENTS AND SCHOOLS?

- School Feedback Report: Teachers will receive group feedback of their classrooms' data and suggestions for incorporating the results into the curriculum, including relevant learning resources. Feedback reports may be used by teachers to plan future lessons and to examine current students' eating and physical activity behaviours.
- Individual Feedback: Upon completing the food intake recall, students will receive information about their diets for that day, based on Canada's Food Guide to Healthy Eating. Students will develop a better understanding of their eating patterns, ways to improve their diets, and the benefits to healthy living.

FOR MORE INFORMATION, CONTACT:

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Parent Information Letter

Title of Research Project: Web-Based Nutrition and Physical Activity Survey, part of the Alberta Healthy Schools Initiative: Beyond an Apple a Day Project

This letter describes research being conducted at [name of school] by the University of Alberta (Department of Agricultural, Food & Nutritional Sciences, and the Faculty of Physical Education and Recreation), and the University of Waterloo (Department of Health Studies and Gerontology). Dr. Linda McCargar and Dr. Rhona Hanning are the researchers leading the study, with Dr. Dru Marshall and Dr. John Spence co-investigating. Kate Calengor is the coordinator of the study. We would like to give you some information about the study to help you to decide if your son or daughter should be a part of it.

Your school board and principal have given us permission to conduct this research. This study has received ethics clearance from the Human Research Ethics Review Board in the Faculty of Agriculture, Forestry and Home Economics at the University of Alberta.

Why is the study being done?

Students in the grade nine and ten age group are going through a time of physical and emotional changes. They are experiencing the final stages of the adolescent growth spurt with rapid bone development and increasing independence in food behaviours. Previous surveys have shown that children and teens do not get enough food energy, calcium, iron, and are becoming less active. However, there is very little information on the diet and activity levels of Alberta youth.

Who are we looking for?

Teachers of grades nine and ten students at [name of school] are being invited to allow their classes to participate in the research. If you are the parent of a [name of school] grade nine or ten student, we hope you will agree to his or her participation in the research.

What does my son/daughter have to do?

In order to participate in this survey, your son/daughter **must return a signed and completed consent form** to their teacher.

All of the students in participating classes will be invited to complete a nutrition and physical activity survey on the Internet during class time. This survey is designed to examine food and physical activity habits. We want to know what types of food your son/daughter eats and how they feel about certain foods. Upon completing the survey, your son or daughter will receive immediate feedback on their diet based on Canada's Food Guide to Healthy Eating. If your son or daughter wishes to revisit the web site on another day, the same set of questions about his/her food behaviour will be available. Revisiting the survey is optional, and may be done on a computer at school, at home, or in the community.

It will take approximately one class period to learn about the web site and complete the on-line survey. All students that take part in the survey will be entered into a draw for small prizes after completion of the study.

Why is the survey web-based?
In the past, other nutrition surveys have included only a small number of participants due to practical issues such as cost. The proposed research will use a web-based tool to deliver a nutrition and physical activity survey to a large number of Alberta children and adolescents. This will result in the most complete assessment of the diet and physical activity of Alberta youth to date.

What will the information be used for?
The information collected from the web-based survey will be used to increase our understanding of the nutrition and physical activity habits of adolescents in Alberta. It will also be used to make recommendations about the types of programs needed to improve the health of Alberta youth. All responses will be anonymous and research journal articles and reports will be written based on the group results obtained from this study; individual results will not be referred to in any publication, report, or presentation. We will compare our results to those of a similar study underway in Ontario. As well, if we re-create this survey in the future, we will use the 2003 survey as a comparison for other data. Your son or daughter's involvement in this project does not obligate them in any way to participate in future surveys.

What if I change my mind about participation?
Being in the study is completely voluntary. Your son or daughter is free to refuse to answer any question(s). Being in the study does not pose any risks for your son or daughter. If you and your son or daughter agrees now to participate, but either of you change your mind later, either you or your son or daughter can withdraw at any time.

The final decision to participate in this study must be made by the individual student and his/her parent(s) or guardian(s). Your co-operation in permitting your son or daughter to take part in this research is greatly appreciated. However, there is no penalty of any kind if he/she does not participate. If you have any questions or concerns, please contact Kate Calengor at (780) 492-3700.

Will information about the student go back to the school?
Student names will not be included on the survey; the survey is anonymous. Individual student responses will be kept completely confidential and no individual results will be made available to school or other personnel. Each student will have a unique identification and password. The web site will be password protected so that unauthorized users will be unable to gain access.

Only the researchers at the University of Alberta and the University of Waterloo will have access to the locked computer files on which we will keep your information. These computers are located in locked offices. The data will be permanently stored on CD in electronic form, which will be held in locked offices at the University of Alberta and the Health Behaviour Research Group, University of Waterloo. Funders and the Advisory Committee will not have access to this information.

Identification codes, not participant names, will be used in the data analysis. All data are published in group form so that it will not be possible to determine the responses from any individual student. The teacher will have access to the group results and we will provide feedback to their class. This ensures that the study can support and enhance the curriculum.

Who is funding this project?
This research is funded by the Beef Information Centre.

How do I include my son/daughter in the project?
If you would like to include your son or daughter in this exciting research project, please complete and sign the attached consent form and have your son/daughter return it to their teacher as soon as possible.

If we do not receive a signed and completed consent form from you, your son/daughter will not be able to participate in the survey.

Sincerely,

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Study Coordinator,
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Phone: 780-492-3700

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[Date]

Student Information Letter

This letter is a request for your help in a study we are carrying out at the University Alberta and at the University of Waterloo. Dr. Linda McCargar and Dr. Rhona Hanning are the researchers leading the study, with Dr. Dru Marshall and Dr. John Spence co-investigating. Kate Calengor is the coordinator of the study. We would like to give you some information about the study and what you need to do to be a part of it.

Why is the study being done?
There is only a little information available on the diet and physical activity of Alberta pre-teens and teenagers. Your diet and activity can affect your growth and health. Students throughout Alberta, in grades nine and ten, will be asked to participate in this project. This will provide us with a better understanding of eating patterns of adolescents and things that influence these patterns. We hope to use this information to make recommendations on how to improve the health of teenagers. As well, since a similar project is being conducted in Ontario (investigator: Dr. Rhona Hanning), the results obtained from this survey will be compared to the results in Ontario to see if there is a difference in how teenagers are eating between the two provinces. We may also conduct similar surveys in the future and compare the results obtained from this survey with these future surveys.

Who are we looking for?
Teachers of grades nine and ten students in your school are being invited to allow their classes to participate in the research. If you are a [name of school] grade nine or grade ten student, we would welcome your help with the research.

What do I have to do?
If you wish to participate, your parents and/or guardians have to sign and complete the consent form that was delivered to them, either by you or the school. This form needs to be given to your teacher before you can complete the survey. Your teacher will assign you a password that will allow you to sign in to our web survey. We will first ask you to complete the survey on the Internet at school. This survey is designed to examine food and physical activity habits. We want to know what types of food you eat and how you feel about certain foods. It should require approximately one period of class time. After completing the survey, if you wish to go back to the web site on another day, the same set of questions about your eating habits will be available. Revisiting the survey is optional, and may be done on a computer at school, at home, or in your community.

Why is the survey web-based?
A web-based survey was selected so that we could have a very large number of students from Alberta fill out the survey. This will result in the biggest survey of adolescent diet and physical activity to date.

What if I want to quit being in the study?
Being in the study is completely voluntary. You are free to say you don't want to answer any question. You can also decide to stop all together at any time. Being in the study does not have any risks for you. If you have any questions about the study, please contact Kate Calengor at (780) 492-3700 or calengor@ualberta.ca.

We have received permission from the school board and your school principal to conduct this research. This study has been reviewed by, and received ethics clearance from the Human Research Ethics Board at the University of Alberta.

Will information about me go back to my school?
The survey is anonymous. This means that your name will not be on the survey. You will have a unique identification and password. The web site will be password protected so that unauthorized users will be unable to gain access. All the information that you give to the research group will be kept private. We will not give information about your answers to any other group, including your school. No one at your school will know your answers. When we report survey results, no individuals will be identified. Only the researchers at the University of Waterloo and University of Alberta will have access to the locked computer files on which we will keep your information. These computers are located in locked offices. Your teacher will receive group averages for your class as a whole.

The final decision to participate in this study must be made by you and your parents. We hope you enjoy participating in this survey - and learn from the information on your diet that you receive at the end of the survey based on Canada's Food Guide to Healthy Eating. However, there is no penalty of any kind if you do not participate.

Sincerely,

Kate Calengor, MSc Candidate
Study Coordinator,
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& Nutritional Science
University of Alberta
Phone: 780-492-3700

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Professor,
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CONSENT FORM

Please sign, date and return this form to your son/daughter's teacher

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Consent Form

(Please sign, date and return this form to your son/daughter's teacher)

Title of Research Project: Web-Based Nutrition and Physical Activity Survey, part of the Alberta Healthy Schools Initiative: Beyond an Apple a Day Project

Investigators:

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Faculty of Physical Education
& Recreation
University of Alberta

Consent: Please circle your answers:

Do you understand that you have been asked to include your son or daughter in a nutrition research study?

Yes **No**

Have you read and received a copy of the attached Information Letter?

Yes **No**

Do you understand that there are no risks involved in including your son or daughter in this research study?

Yes **No**

Do you understand that your son or daughter can quit taking part in this study at any time? Neither you nor your child has to say why and it will not affect the benefits or prizes your son or daughter will receive.

Yes **No**

Was confidentiality adequately explained to you?

Yes **No**

Do you understand who will be able to access the nutrition information collected from this study?

Yes **No**

Do you understand that the information obtained from this project may be compared to results obtained from a similar survey in Ontario and that the information may also be compared to results from future surveys?

Yes **No**

Will you consent to having your son or daughter take part in this research study?

Yes **No**

Please sign and date below:

Date: ______________________________

Signature of parent/guardian:_____________________

Name of parent/guardian:___________________

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CONSENT FORM

Please sign, date and keep this form for your records

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Investigators:

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Consent: Please circle your answers:

Do you understand that you have been asked to include your son or daughter in a nutrition research study?

Yes **No**

Have you read and received a copy of the attached Information Letter?

Yes **No**

Do you understand that there are no risks involved in including your son or daughter in this research study?

Yes **No**

Do you understand that your son or daughter can quit taking part in this study at any time? Neither you nor your child has to say why and it will not affect the benefits or prizes your son or daughter will receive.

Yes **No**

Was confidentiality adequately explained to you?

Yes **No**

Do you understand who will be able to access the nutrition information collected from this study?

Yes **No**

Do you understand that the information obtained from this project may be compared to results obtained from a similar survey in Ontario and that the information may also be compared to results from future surveys?

Yes **No**

Will you consent to having your son or daughter take part in this research study?

Yes **No**

Please sign and date below:

Date: ______________________________

Signature of parent/guardian:_____________________

Name of parent/guardian:___________________

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Fax: 780.492.4265

Student Assent Form – Web-Survey

This questionnaire is designed to examine your food habits and those of other students your age. We want to know what sorts of things you eat, what you like to eat, and how you feel about certain foods. We know that not everyone feels the same way, or eats the same things, but we are very interested in your answers to the following questions.

The questionnaire is strictly confidential. No one, except the researchers, will see your finished questionnaire, so please be as honest as you can. If there is a question that you don't know how to answer or don't want to answer, that's okay, just go on to the next one.

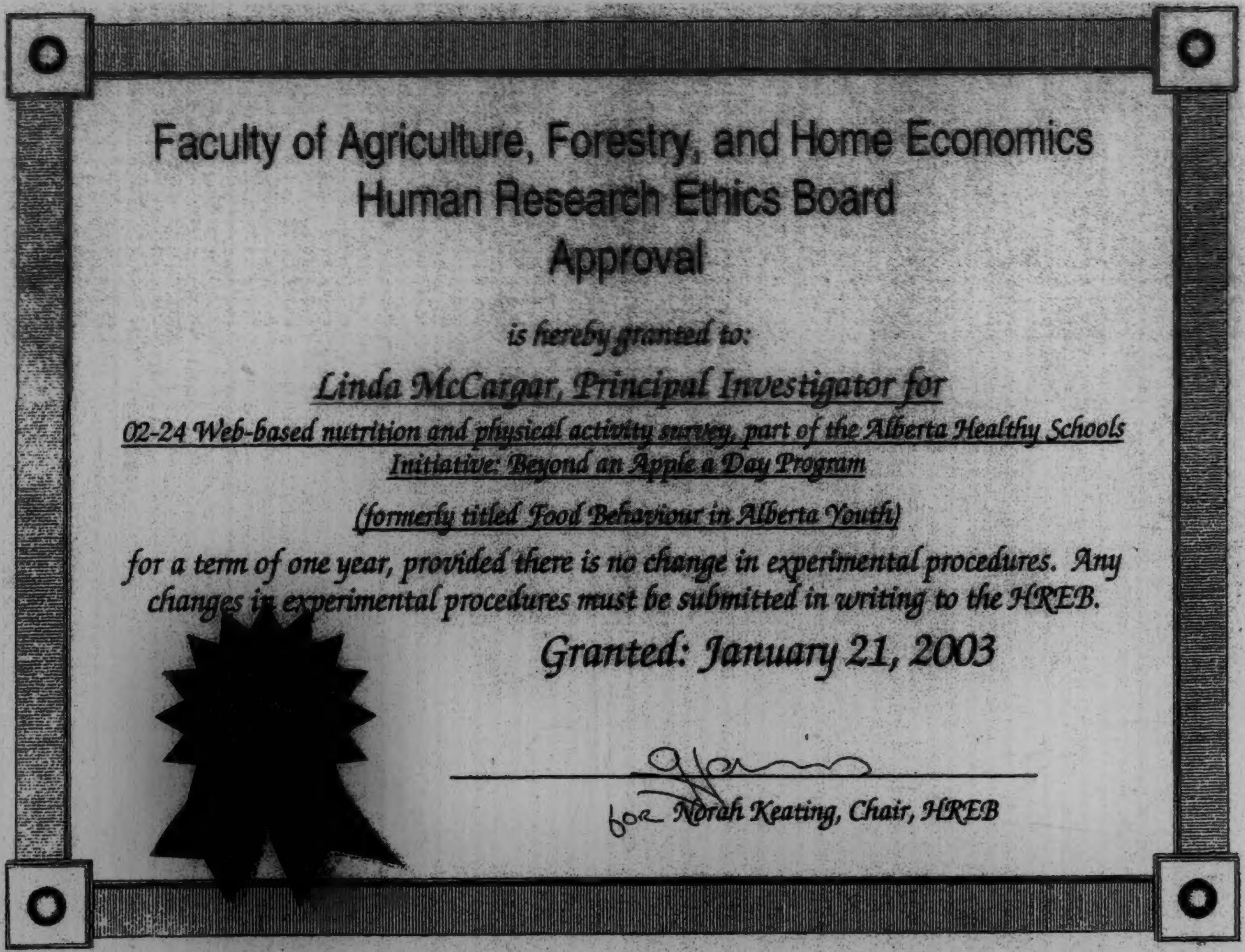
Thanks for helping us with this very valuable research!

Do you agree to participate in this survey?

Yes **No**

*****Note: If student did not choose "yes", they could not proceed with the survey***

Appendix B: Ethical Approval – Web-Survey I



Faculty of Agriculture, Forestry, and Home Economics
Human Research Ethics Board
Approval

is hereby granted to:

Linda McCargar, Principal Investigator for

02-24 Web-based nutrition and physical activity survey, part of the Alberta Healthy Schools Initiative: Beyond an Apple a Day Program

(formerly titled Food Behaviour in Alberta Youth)

for a term of one year, provided there is no change in experimental procedures. Any changes in experimental procedures must be submitted in writing to the HREB.

Granted: January 21, 2003

for *Norah Keating, Chair, HREB*

Appendix C: BENEFIT Information Package

1. Information Letter for Board Recruitment
2. Information Letter for School Recruitment
3. Parent Information Letter
4. Student Information Letter
5. Consent Form
6. Student Assent Form
7. Student Assent Form – Web-Survey

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INFORMATION LETTER for Board Recruitment

[Date]

Dear [Name]:

RE: BENEFIT (Behavioural, Nutrition, Exercise and Fitness Investigation of Teens)

We would like to invite the [Board Name] to participate in a continuing study examining food, activity, and general health behaviours in Alberta youth. This research will investigate the nutrition, physical activity, and behavioural choices of students in grades seven through ten by using on-site quantitative assessments such as height, weight, body composition, aerobic fitness, walking (steps per day), and a web-based survey. Each student will receive a pedometer (step counter) as well as brief individual feedback immediately upon completion of the computer-based survey. This survey complements the Comprehensive School Health Model and new curriculum.

As you know, students in grades seven through ten experience many physiological and psychological milestones, including the adolescent growth spurt with rapid bone development, and increasing autonomy in food and activity choices. There is little information on the diet and physical activity behaviours of Alberta youth, however dietary surveys elsewhere indicate that teens consume insufficient amounts of energy, calcium, iron, and may have low levels of physical activity. Obesity is particularly concerning, as many overweight and obese children become obese adults, at risk for diabetes and heart disease. Thus the lifestyle behaviours of Alberta youth are of tremendous interest.

The web-based tool was developed by Dr. Rhona Hanning at the University of Waterloo, and has previously been used to survey over 6500 Alberta students. The web-based tool presents the opportunity to collect information from a large, diverse sample; and information provided from this research study will help us to validate the web-based methodology as a practical and realistic method for assessing nutrition and physical activity behaviours in youth. Your school board and schools within your board have been selected to participate in this survey. Please find attached copies of the following: 1) the web-survey questions, 2) the information letter and consent form that will be sent to parents, 3) the information letter for the students, and 4) our ethics approval letter.

The following schools from within your board were selected: [School Names]. In the event an insufficient number of schools from your board can participate, we have selected back-up schools, which may be required in order to complete the research survey. These schools have been selected as back-up schools: [School Names]. If you choose to include your school board in this research study, a member of our staff will send information packages to each school listed above to determine interest from individual principals.

This study has been reviewed by, and received ethics clearance from the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board at the University of Alberta. The research is funded by the Canadian Institutes of Health Research and the Alberta Heritage Foundation for Medical Research.

We would like an opportunity to speak with you to discuss our project and your school board's protocol for the approval of research projects. We appreciate the strain on school boards and schools at this time and do not wish to create more pressure. If there is anything we can do to make it easy for your schools to participate, please let us know. One of our staff will call you to determine your interest. In the meantime, if you have any questions, please call Kate Calengor at (780) 492-3700 or by e-mail at calengor@ualberta.ca. We look forward to further collaboration with you on this project.

Sincerely,

Kate Calengor, PhD Student	Linda McCargar, PhD, RD
Project Coordinator,	Professor,
Dept of Agricultural, Food	Dept of Agricultural, Food
& Nutritional Science	& Nutritional Science
University of Alberta	University of Alberta
Phone: 780-492-3700	Phone: 780-492-9287

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INFORMATION LETTER for School Recruitment

[Date]

Dear [Name]:

RE: BENEFIT (Behavioural, Nutrition, Exercise and Fitness Investigation of Teens)

The University of Alberta has the approval of your school board to invite [school name] to participate in a continuing study examining food, activity, and general health behaviours in Alberta youth. This research will investigate the nutrition, physical activity, and behavioural choices of students in grades [seven through ten] by using on-site quantitative assessments such as height, weight, body composition, aerobic fitness, walking (steps per day), and a web-based survey. Each student will receive a pedometer (step counter) as well as brief individual feedback immediately upon completion of the computer-based survey. This survey complements the Comprehensive School Health Model and new curriculum.

As you know, teenagers experience many physiological and psychological milestones, including the adolescent growth spurt with rapid bone development, and increasing autonomy in food and activity choices. There is little information on the diet and physical activity behaviours of Alberta youth, however dietary surveys elsewhere indicate that teens consume insufficient amounts of energy, calcium, iron, and may have low levels of physical activity. These have the potential to exert a strong deleterious impact on future health and increase the risk of chronic disease in later life. Through better understanding of the lifestyle patterns of Alberta youth, and variables that influence this pattern, targeted healthy eating and active living programs and strategies can be designed.

The web-based tool was developed by Dr. Rhona Hanning at the University of Waterloo, and has previously been used to survey over 6500 Alberta students. The web-based tool presents the opportunity to collect information from a large, diverse sample; and information provided from this research study will help us to validate the web-based methodology as a practical and realistic method for assessing nutrition and physical activity behaviours in youth. Your school has been selected to participate in this survey. Please find attached copies of the following: 1) the web-survey questions, 2) the information letter and consent form that will be sent to parents, 3) the information letter for the students, and 4) our ethics approval letter.

Upon your approval of this research study, we would invite all grade [seven through ten] students (if possible) in your school to participate. A member of our research staff would then contact participating teachers to discuss details of the project and to make arrangements for researchers to conduct the study within your school.

The research has been reviewed by and received ethics clearance from the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board at the University of Alberta. The research is funded by the Canadian Institutes of Health Research and the Alberta Heritage Foundation for Medical Research.

We would like an opportunity to speak with you to discuss this project and the possibility of your school's participation. We appreciate the strain on schools at this time and do not wish to create more pressure. If there is anything we can do to make it easy for your school to participate, please let us know. One of our staff will call you to determine your interest. In the meantime, if you have any questions, please call Kate Calengor at (780) 492-3700, or by email at calengor@ualberta.ca. We look forward to further collaboration with you on this project.

Sincerely,

Kate Calengor, PhD Student	Linda McCargar, PhD, RD
Project Coordinator,	Professor,
Dept of Agricultural, Food	Dept of Agricultural, Food
& Nutritional Science	& Nutritional Science
University of Alberta	University of Alberta
Phone: 780-492-3700	Phone: 780-492-9287

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Parent Information Letter

Title of Research Project: BENEFIT
(Behavioural, Nutrition, Exercise and Fitness Investigation of Teens)

This letter describes research being conducted at your son or daughter's school by the University of Alberta (Dept. of Agricultural, Food & Nutritional Science). Dr. Linda McCargar is the researcher leading the study, and Kate Calengor is the coordinator of the study. We would like to give you some information about the study to help you to decide if your son or daughter should be a part of it.

Your school division and principal have given us permission to conduct this research. This study has received ethical approval from the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board at the University of Alberta.

Why is the study being done?
Teenagers are going through a time of physical and emotional changes. They are experiencing the final stages of the adolescent growth spurt with rapid bone development and increasing independence in food and activity behaviours. Previous surveys have shown that children and teens do not get enough food energy, calcium, iron, and are becoming less active. However, there is very little information on the diet and activity levels of Alberta youth.

Who are we looking for?
Classrooms in your son or daughter's school are being invited to participate in this research. The study will involve 500 grade seven through ten students within Alberta. If you are the parent/guardian of a student invited to take part in this research study, we hope you will agree to his or her participation in the research.

What does my son/daughter have to do?
A student will not be included in the study if a parent or guardian indicates that he or she does not want the student to participate, or if the student does not agree to take part. In order to participate in this survey, your son/daughter **must return a signed and completed consent form** to their teacher.

All of the students in participating classes will be invited to complete a nutrition and physical activity survey on the Internet during class time (this will occur twice). This survey is designed to examine food and physical activity habits. We want to know what types of food your son/daughter eats and how they feel about certain foods. Upon completing the survey, your son or daughter will receive immediate feedback on their diet based on Canada's Food Guide to Healthy Eating.

Your son or daughter will also be asked to consent to participate in the following assessments:

- Height and weight;
- Bioelectrical impedence analysis (this is a measure of % body fat done using a bathroom-type scale);
- Waist circumference;
- Diet and physical activity (assessed with questionnaires, interviews, and food records),
- Walking behaviour (measured by a pedometer or step-counter, which your son/daughter will receive), and they will be asked to record steps/day for 3 consecutive days in a daily diary; and
- Fitness (assessed with a 20 meter shuttle run).

If your son or daughter wishes to revisit the web site on another day, the same set of questions about his/her food behaviour will be available. Revisiting the survey is optional, and may be done on a computer at school, at home, or in the community.

What will the information be used for?
The information collected from the study will be used to increase our understanding of the nutrition and physical activity habits of adolescents in Alberta. It will also be used to help researchers verify the web-based method of collecting information. All responses will be anonymous and research journal articles and reports will be written based on the group results obtained from this study; individual results will not be referred to in any publication, report, or presentation. We will compare our results to those of previous surveys conducted in both Alberta and Ontario. As well, if we re-administer this survey in the future, we will use the results from this study as a comparison for other data. Your son or daughter's involvement in this project does not obligate them in any way to participate in future surveys.

What if I change my mind about participation?
Being in the study is completely voluntary. Your son or daughter is free to withdraw at any time until June 30, 2006. If you and your son or daughter agrees now to participate, but either of you change your mind later that is fine. Just let us know.

The final decision to participate in this study must be made by the individual student and his/her parent(s) or guardian(s). Your co-operation in permitting your son or daughter to take part in this research is greatly appreciated. However, there is no penalty of any kind if he/she does not participate. If you have any questions or concerns, please contact Kate Calengor at (780) 492-3700.

Where is the information kept?
Only the researchers at the University of Alberta will have access to the information. Everything will be coded by an identification number, not a student's name. Computer and paper files will be kept in locked cabinets and locked offices at the University of Alberta. All individual data will be kept strictly confidential. Funders and the Advisory

Committee will not have access to this information. The web-based survey will be password protected so that unauthorized users will be unable to gain access. Identification codes, not participant names, will be used in the data analysis. All data are published in group form so that it will not be possible to determine the responses from any individual student.

Who is funding this project?
This research is funded by the Canadian Institutes of Health Research and the Alberta Heritage Foundation for Medical Research.

How do I include my son/daughter in the project?
If you would like to include your son or daughter in this research project, please complete and sign the attached consent form and have your son/daughter return it to their teacher as soon as possible.

What if I have questions about the study?
Please contact us if you require additional information.

Sincerely,

Kate Calengor, PhD Candidate	Linda McCargar, PhD, RD
Project Coordinator,	Professor,
Dept of Agricultural, Food	Dept of Agricultural, Food
& Nutritional Science	& Nutritional Science
University of Alberta	University of Alberta
Phone: 780-492-3700	Phone: 780-492-9287

If you have any concerns, complaints or consequences regarding this research project, you may contact Georgie Jarvis, Administrative Support to the AFHE Research Ethics Board, 2-14 Ag/For Centre, U of A, Edmonton AB T6G 2P5, 780-492-4931, Fax 780-492-0097

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Student Information Letter

Title of Research Project: BENEFIT
(Behavioural, Nutrition, Exercise and Fitness Investigation of Teens)

This letter is a request for your help in a study we are doing at the University Alberta. We would like to give you some information about the study and what you need to do to be a part of it.

Why is the study being done and what will the data be used for?
We want to collect information on what students in Alberta are eating, how active they are, and other factors that influence nutrition and physical activity. We hope to use this information to make recommendations on how to improve the health of teenagers.

What do I have to do?
If you wish to participate, your parents and/or guardians have to sign and complete the consent form. This form needs to be given to your teacher before you can complete the study. We will then have you complete a survey on the Internet at school designed to examine food and physical activity habits. As well, we will ask you some questions about your nutrition and physical activity and have you to complete a physical challenge and other physical assessments such as height and weight. You will also be given a step-counter (pedometer) to count the steps that you take each day.

What if I want to quit being in the study?
Being in the study is completely up to you. You are free to say you don't want to answer any question or complete any assessment. You can also decide to stop altogether at any time. If you have any questions about the study, please contact Kate Calengor at (780) 492-3700 or calengor@ualberta.ca.

Will information about me go back to my school?
You will have an individual identification number, so all the information you give to the research group will be kept private. We will not give information about your answers to any other group, including your school. When we report survey results, your name will not be used.

The final decision to participate in this study must be made by you and your parents. We hope you enjoy participating in this survey – and learn from the information that you receive at the end of the survey. However, it is not a problem if you decide not to participate.

Sincerely,

Kate Calengor, PhD Candidate	Linda McCargar, PhD, RD
Project Coordinator,	Professor,
Dept of Agricultural, Food	Dept of Agricultural, Food
& Nutritional Science	& Nutritional Science
University of Alberta	University of Alberta
Phone: 780-492-3700	Phone: 780-492-9287

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CONSENT FORM

Please COMPLETE, sign, date and return this form to your son/daughter's teacher

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afns-chair@ualberta.ca
Tel: 780.492.3239
Fax: 780.492.4265

Consent Form

(Please COMPLETE, sign, date and return this form to your son/daughter's teacher)

Title of Research Project: BENEFIT
(Behavioural, Nutrition, Exercise and Fitness Investigation of Teens)

Investigators:

Kate Calengor, PhD Candidate	Linda McCargar, PhD, RD
Project Coordinator,	Professor,
Dept of Agricultural, Food	Dept of Agricultural, Food
& Nutritional Science	& Nutritional Science
University of Alberta	University of Alberta
Phone: 780-492-3700	Phone: 780-492-9287

Consent: Please circle your answers:

Do you understand that you have been asked to include your son or daughter in a nutrition, physical activity, and behavioural research study?

Yes **No**

Have you received and read a copy of the attached Information Letter?

Yes **No**

Do you understand that there are minimal risks involved in including your son or daughter in this research study?

Yes **No**

Do you understand that your son or daughter can quit taking part in this study at any time? Neither you nor your child has to say why and it will not affect the benefits your son or daughter will receive. Final withdrawal date is June 30th, 2006

Yes **No**

Was confidentiality adequately explained to you in the Information Letter?

Yes **No**

Do you understand who will be able to access the information collected from this study?

Yes **No**

Do you understand that the information obtained from this project (group results) may be used for theses, publications, presentations, and as a comparison to results obtained from both previous and future surveys conducted in both Alberta and Ontario?

Yes **No**

WILL YOU CONSENT TO HAVING YOUR SON OR DAUGHTER TAKE PART IN THIS RESEARCH STUDY?

Yes **No**

Please sign and date below:

Signature of parent/guardian:______________________________
Name of parent/guardian:__________________________________

Date: ______________________________
Name(s) of son(s)/daughter(s):______________________________

As per research guidelines, the anonymous data will be stored for seven years following time of collection. There will be no paper copies of the data. All data will be stored electronically (on CD) and kept in locked offices on password-protected computers.

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Student Assent Form

Write in the bottom part of this page to let us know if you want to join this research study.

Please check (√) one of the following choices:

I want to join this research study __________

I don't want to join this research study __________

My name is: ____

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Student Assent Form – Web-Survey

This questionnaire is designed to examine your food habits and those of other students your age. We want to know what sorts of things you eat, what you like to eat, and how you feel about certain foods. We know that not everyone feels the same way, or eats the same things, but we are very interested in your answers to the following questions.

The questionnaire is strictly confidential. No one, except the researchers, will see your finished questionnaire, so please be as honest as you can. If there is a question that you don't know how to answer or don't want to answer, that's okay, just go on to the next one.

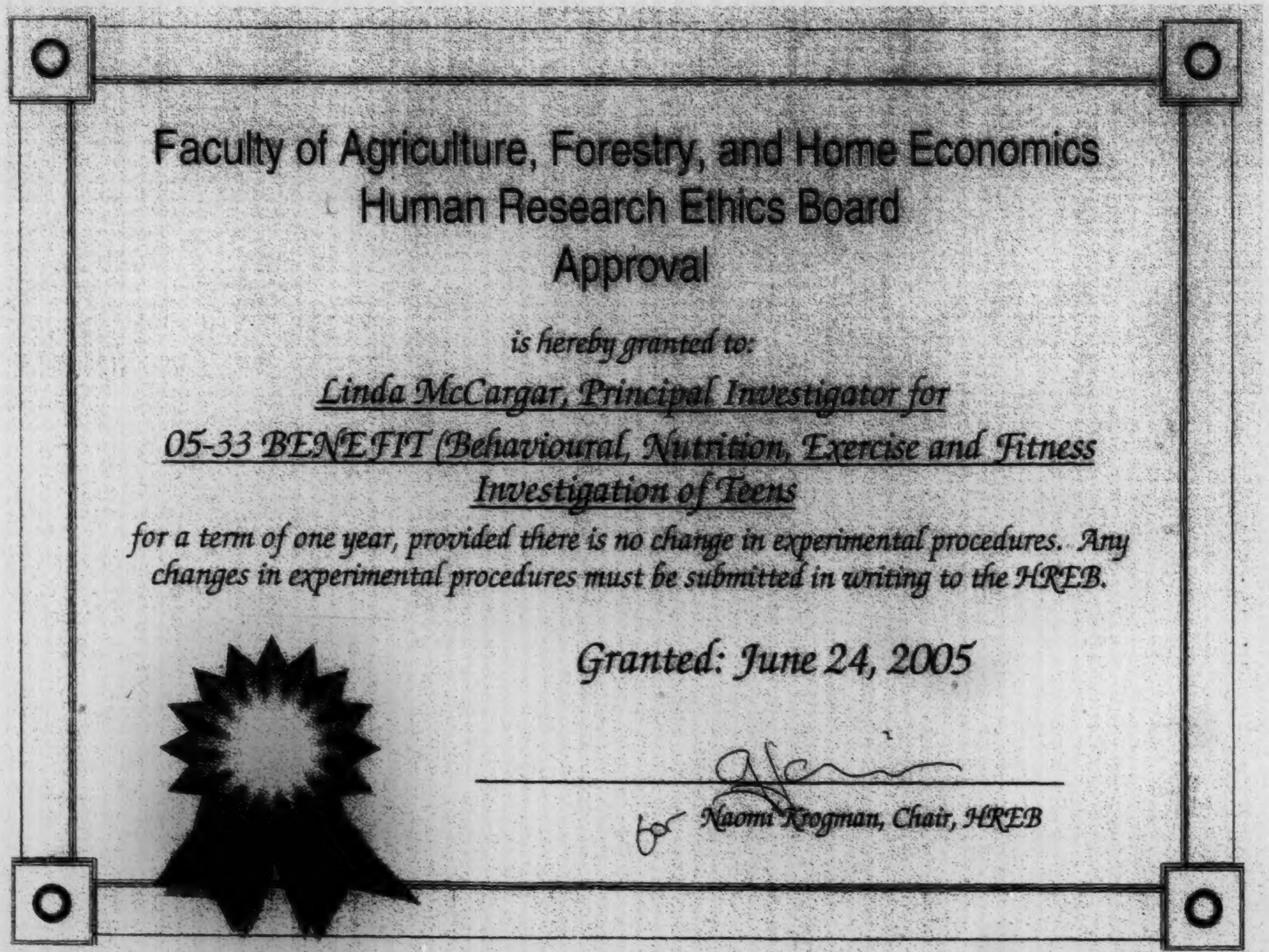
Thanks for helping us with this very valuable research!

Do you agree to participate in this survey?

Yes **No**

***Note: If student did not choose "yes", they could not proceed with the survey*

Appendix D: Ethical Approval – BENEFIT



Faculty of Agriculture, Forestry, and Home Economics
Human Research Ethics Board
Approval

is hereby granted to:

Linda McCargar, Principal Investigator for

05-33 BENEFIT (Behavioural, Nutrition, Exercise and Fitness Investigation of Teens

for a term of one year, provided there is no change in experimental procedures. Any changes in experimental procedures must be submitted in writing to the HREB.

Granted: June 24, 2005

for *Naomi Krogman, Chair, HREB*

Appendix E: Waist Circumference and Bioelectrical Impedance Analysis

As part of the research used to assess the reliability and validity of the web-based survey methodology for assessing nutrition and physical activity behaviours and weight status of Alberta youth (**Chapter 5**), waist circumference (WC) and bioelectrical impedance analysis (BIA) were also measured during the in-school assessments. Waist circumference was used to determine prevalence of youth at risk for developing obesity-related disorders (Katzmarzyk, 2004), while BIA was used to determine the percent body fat of students. Data were collected between October and November of 2005.

All measurements were completed by trained research staff, and were done in a private setting. Waist circumference was measured by placing a flexible heavy-duty inelastic tape measure at the midpoint between the lowest rib and iliac crest while the student stood balanced on both feet, with their arms at their sides and the feet together. The measurement was taken at the end of a normal expiration (Wang, Thornton, Kolesnik, & Pierson, 2000). All waist circumference measurements were completed by the same trained anthropometrist. Waist circumference values were compared to reference data for Canadian youth that were developed using nationally representative data from adolescents. Smoothed and weighted age- and sex-specific percentile curves were developed for Canadian youth 11 to 18 years of age (Katzmarzyk, 2004).

Compared to reference data for Canadian youth 11 to 18 years of age (Katzmarzyk, 2004), 12.7% of students in the present research had a high waist circumference relative to age- and sex-matched peers. In this sample 5.2% of students had a waist circumference of greater than or equal to the 90th percentile and less than the

95th percentile, and 7.5% of students had a waist circumference at or above the 95th percentile as defined by Katzmarzyk (Katzmarzyk, 2004). Average waist circumference for boys (65.9 ± 9.8 cm, n = 215) was significantly greater than the average waist circumference for girls (62.7 ± 8.5 cm, n = 226) ($t = 3.62$; $p < 0.001$).

Although bioelectrical impedance analysis (BIA) was used in this study, results are not presented. The impedance values of this sample did not reflect values that are necessary when using equations that have been previously validated in this age group. With exception to the equation by Houkooper et al. (Houtkooper, Going, Lohman, Roche, & Van Loan, 1992), very few equations have been developed and validated specifically for adolescents. Because the relationship between bioelectrical resistance and total body water is influenced by age (Deurenberg, Kusters, & Smit, 1990), it is essential to have age-specific equations when utilizing BIA for the measurement of body composition. In the present research impedance values were well below the range necessary to calculate body mass in this sample.

References:

Deurenberg, P., Kusters, C. S., & Smit, H. E. (1990). Assessment of body composition by bioelectrical impedance in children and young adults is strongly age-dependent. *European Journal of Clinical Nutrition, 44*(4), 261-268.

Houtkooper, L. B., Going, S. B., Lohman, T. G., Roche, A. F., & Van Loan, M. (1992). Bioelectrical impedance estimation of fat-free body mass in children and youth: a cross-validation study. *Journal of Applied Physiology, 72*(1), 366-373.

Katzmarzyk, P. T. (2004). Waist circumference percentiles for Canadian youth 11-18y of age. *European Journal of Clinical Nutrition, 58*(7), 1011-1015.

Wang, J., Thornton, J. C., Kolesnik, S., & Pierson, R. N., Jr. (2000). Anthropometry in body composition. An overview. *Annals of the New York Academy of Sciences, 904*, 317-326.

Appendix F: BENEFIT 3-day Record Book (Instructions Only)

THREE-DAY DIETARY INTAKE AND PEDOMETER RECORD

BENE[redacted]

Behavioural, Nutrition, Exe
Fitness Investigation of Teens

Student Name: ______________________________

2005

University of Alberta
Department of Agricultural, Food and Nutritional Science

Grade Level: ____________________ Gender (circle one): M / F

Date of Birth: _____ (Day) _____ (Month) _____ (Year)

Record Dates: _____ (Day) _____ (Month) _____ (Day) _____ (Month) _____ (Day) _____ (Month)

Thank you for your participation and cooperation in helping with this study. Please look closely at the Sample Day before beginning your Dietary Intake Record. **If you have any questions about filling out your Three-Day Dietary Intake and Pedometer Record, please phone:**

Kate Calengor at (780) 492-3700

INSTRUCTIONS FOR RECORDING

DAILY FOOD INTAKE

One purpose of this study is to discover everything you eat and drink during a three-day period. It is important to record ALL foods and beverages – whether it is a full course meal at home or a quick can of pop at school. Before you start recording your intake, please read the following instructions and the Sample Day.

The Three-Day Dietary Intake Record has a separate section for every day (see Day 1, Day 2, Day 3 on top each page). Each day is broken up into 6 eating times:

1. Breakfast
2. Morning Snacks
3. Lunch
4. Afternoon Snacks
5. Dinner
6. Evening Snacks

It is a good idea to carry your Dietary Intake Record book with you and record your entries as soon after eating as possible. Foods and beverages consumed away from home – at school, at the mall, at a restaurant – are just as important as those eaten at home. Please include the following information on your food record:

1. **FOOD AND BEVERAGE ITEMS** Column: Enter all foods and beverages consumed at the meal or snack time. Please record the specific type of food (for example: *WHOLE WHEAT* bread, *FROSTED FLAKES* cereal). In the same column, record all toppings or items added at the time of eating (for example: sugar, syrup, jam, butter, mayonnaise, gravy, milk, salt, etc.). For combination foods, please include detailed information on each item. For example: If you had a tuna sandwich, you would list the following foods and include detailed information for each of them: white bread, mayonnaise, celery, solid white tuna, salt.

2. **DESCRIPTION OF ITEM** Column: For every food or beverage item listed, include the following (if applicable):
   - **Brand**: *MIRACLE WHIP* mayonnaise, *PIZZA HUT DEEP DISH* pizza, *OREO* cookie
   - **Type of flavour**: *BLUEBERRY* muffins, *STRAWBERRY* yogurt
   - **Method of cooking**: *FRIED, BAKED, BBQ'D, HOMEMADE, BOILED*
   - **All other relevant information included on food label:** *LOW FAT* ranch salad dressing, *28% M.F. (MILK FAT)* cheddar cheese, *LEAN* Ground Beef

3. **UNIT OF MEASURE** Column: For every item consumed, enter the unit of measure you are using for this item. For example: enter the word "cup", "grams", "piece", "ounce", "number", "teaspoon", or "tablespoon". Enter a unit of measure not only for the menu item, but for toppings or items added as well. Each entry must have its own unit of measure. Use measuring cups and spoons whenever possible.

4. **NUMBER OF UNITS** Column: In this area, record the number of units consumed. Include the amount of the food or beverage item and the amount of any topping or items added.

Fill in the three blanks on the bottom of each record. Indicate the time of your meal or snack, where it was eaten (e.g. at home, at a restaurant, in class), and whom it was eaten with (e.g. friends, parent). If you did not eat a meal or snack, please place a check mark (✓) in the space provided on the bottom of the page, so that we do not think you forgot to record it.

Daily check: in the evening, after you have recorded everything for the day, go back over your entries to make sure you have included as much detail as possible for each item. Also check to ensure the blanks are completed on the bottom of the page.

All foods and beverages you consume every day are important and your Dietary Intake Record should be as accurate as possible. It should also reflect the way you usually eat. Please do not change your normal eating habits for the 3 days you are recording your food intake. Your honesty is crucial to the success of this research study.

INSTRUCTIONS FOR RECORDING

DAILY STEPS (USING YOUR PEDOMETER)

Another purpose of this study is to discover the number of steps you take each day. It is important that you **wear your pedometer from the time you get up to the time you go to bed.**

At the beginning of each day there will be a reminder in your record book to put on your pedometer. At the end of each day, there will be a space in your record book to record your step count.

USING YOUR PEDOMETER

Pedometers are small, plastic gadgets that track the number of steps a person takes. They are simple to use. Keep the following information in mind to make sure that your pedometer accurately records the number of steps you take each day:

1. **HOW DO I USE THE PEDOMETER?**
   The pedometer should be worn on the left or right side of your body directly above the leg, on your waistband. Wear your pedometer from the time you get up to the time you go to bed. After you've put the pedometer on your waistband in the morning, reset it to zero by pushing on the yellow button. Close the pedometer and start moving…don't peek! At bedtime, open the pedometer and write down how many steps you have taken.

2. **WHAT IF I NEED TO TAKE OFF MY PEDOMETER?**
   - Don't take off your pedometer during the day unless it is absolutely necessary. You can do most activities while wearing your pedometer. However, there are a few situations where you may have to take your pedometer off for safety reasons or to keep the pedometer from becoming damaged. Examples of these kinds of situations include:

- Swimming
- Gymnastics
- Bathing or showering

Some contact sports (e.g. hockey, football, rugby)If you are not sure and don't know whether to remove your pedometer or not, talk to your parent(s) or caregiver, your teacher, or the coach leading the activity. They will be able to give you good advice.

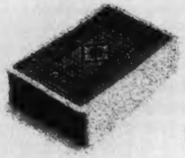
If you do remove your pedometer, but are still active remember to estimate the number of steps you would have taken using this simple formula:

10 minutes of activity = 1000 steps

If you have questions about estimating the number of steps, please talk to your teacher who will pass your question along to the *BENEFIT research team* for an answer.

3. **ARE PEDOMETERS BREAKABLE?**
   YES!!! Pedometers are sturdy and designed to withstand some bumping and jumping. However, they are made out of plastic and will break if they are hit (hard) or if they are submerged in water. Be kind to your pedometer…you get to keep it and wear it after this study is complete!

Serving Size Estimations



A deck of cards

=

3 oz. or 90 grams of meat, fish or chicken

A computer mouse

=

1 small baked potato

A baseball

=

1 cup (250 ml) of salad greens

A hockey puck

=

1 bagel

A golf ball

=

2 tablespoons of peanut butter

A tennis ball

=

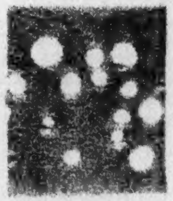
1 medium serving of fruits and vegetables

Prepared by K. Calengor and L. Taylor
University of Alberta, 2005

Serving Size Estimations

4 dice

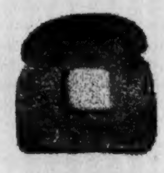
=



1 ounce of cheese

Tip of your thumb

=



1 teaspoon (5 ml) butter, margarine

Light bulb

=

½ cup of other vegetables, cooked, chopped, raw

=

1 serving or ½ cup of rice or pasta

Compact Disc (CD)

=

1 medium pancake

Fist

=

1 serving or 1 cup of a hot or cold beverage

Prepared by K. Calengor and L. Taylor
University of Alberta, 2005

Sample Day

Food and Beverage Items	**DESCRIPTION OF ITEM**	**UNIT OF MEASURE**	**NO. OF UNITS**
Enter all foods and beverages consumed. For combination foods, please include detailed information on each item.	Include a detailed description of each food and drink item consumed including: - Brand name - Flavour - Method of cooking - All other relevant information on food/drink label	Enter unit of measure: for example: cup, grams, ounce, piece, teaspoon, tablespoon	Enter number of units
Spaghetti with tomato sauce:			
Pasta	Spaghetti, cooked	Cup	2
Tomato sauce	Hunt's canned sauce, roasted garlic flavour	Cup	1
Meat balls	Made with extra lean ground beef	Number (1 oz/ball)	5
Parmesan cheese, grated	Kraft, 30% Milk Fat (M.F.)	Tablespoon	1
Garlic Bread:			
Italian Bread	Toasted	Piece (large slice)	3
Garlic Butter		Teaspoon	3
Caesar salad:			
Lettuce	Romaine	Cup	1
Croutons	Safeway brand, garlic flavor	Tablespoon	2
Bacon bits	Simulated flavour, No Name Brand	Tablespoon	2
Caesar salad dressing	Kraft, Fat free	Tablespoon	2
Milk	1%	Cup	1
Tiramisu	Sarah Lee	Slice	1

Fill in blanks: Time of meal/snack: 6:00 pm

Location meal/snack was consumed: at home **I ate this meal/snack with:** friends

Please CHECK (✓) if you did not eat or drink at this meal or snack time: ____

Appendix G: BENEFIT PAQ-C

BENEFIT – *Physical Activity Questionnaire*

ID Number: ______________________ Age: ________

Sex: M ________ F ________ Grade: ________

We are trying to find out about your level of physical activity from *the last 7 days* (in the last week). This includes sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others.

Remember:

1. **There are no right and wrong answers – this is not a test.**
2. **Please answer all the questions as honestly and accurately as you can – this is very important.**

---

1. **Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (Mark only one circle per row.)**

	No	1-2	3-4	5-6	7 times or more
Skipping/jump roping	○	○	○	○	○
Rollerblading	○	○	○	○	○
Active games (tag)	○	○	○	○	○
Walking for exercise	○	○	○	○	○
Bicycling	○	○	○	○	○
Jogging or running	○	○	○	○	○
Swimming laps	○	○	○	○	○
Baseball, softball	○	○	○	○	○
Dance (social, recreational)	○	○	○	○	○
Football	○	○	○	○	○
Racquet sports (badminton, tennis, racquet ball)	○	○	○	○	○
Skateboarding	○	○	○	○	○
Soccer	○	○	○	○	○
Volleyball	○	○	○	○	○
Hockey (roller, ice, street, field)	○	○	○	○	○
Basketball	○	○	○	○	○
Ice skating	○	○	○	○	○
Martial arts (karate, judo)	○	○	○	○	○
Gymnastics	○	○	○	○	○
Other:					
______________________	○	○	○	○	○
______________________	○	○	○	○	○

2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)

I don't do PE .... ○
Hardly ever .... ○
Sometimes .... ○
Quite often .... ○
Always .... ○

3. In the last 7 days, what did you do most of the time at RECESS? (Check one only.)

Sat down (talking, reading, doing school work)..... ○
Stood around.. ○
Walked around a bit.................................... ○
Ran around and played quite a bit..................... ○
Ran and played hard most of the time................. ○
I do not have recess.................................... ○

4. In the last 7 days, what did you normally do AT LUNCH (besides eating lunch)? (Check one only.)

Sat down (talking, reading, doing school work)..... ○
Stood around.. ○
Walked around a bit.................................... ○
Ran around and played quite a bit..................... ○
Ran and played hard most of the time................. ○

5. In the last 7 days, on how many days RIGHT AFTER SCHOOL, did you do sports, or play games in which you were very active? (Check one only.)

None.. ○
1 time.. ○
2 – 3 times.. ○
4 times... ○
5 times... ○

6. In the last 7 days, on how many EVENINGS did you play sports, dance, or play games in which you were very active? (Check one only.)

None.. ○
1 time.. ○
2 – 3 times.. ○
4 times... ○
5 times... ○

7. THIS PAST WEEKEND, how many times did you play sports, dance, or play games in which you were very active? (Check one only.)

None ○
1 time ○
2 – 3 times ○
4 – 5 times ○
6 or more times ○

8. Which ONE of the following describes you best for the last 7 days? Read all five statements before deciding on the one that describes you.

All or most of my free time was spent doing things involving little physical effort ○
I sometimes (1 or 2 times last week) did physical things in my free time ○
I often (3 or 4 times last week) did physical things in my free time ○
I quite often (5 or 6 times last week) did physical things in my free time ○
I very often (7 + times last week) did physical things in my free time ○

9. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

	None	Little bit	Medium	Often	Very often
Monday	○	○	○	○	○
Tuesday	○	○	○	○	○
Wednesday	○	○	○	○	○
Thursday	○	○	○	○	○
Friday	○	○	○	○	○
Saturday	○	○	○	○	○
Sunday	○	○	○	○	○

10. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one.)

Yes ○
No ○

If Yes, what prevented you? ____________________

Appendix H: Web-SPAN Information Package

1. Information Letter for Board Recruitment
2. Information Letter for Private School Recruitment
3. Information Letter for School Recruitment
4. Web-SPAN Summary
5. Letter and Information Package for Teachers
6. Parent Information Letter
7. Student Information Letter (Grades Seven and Eight)
8. Student Information Letter (Grades Nine and Ten)
9. Consent Form
10. Student Assent Form

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INFORMATION LETTER for Board Recruitment

[Date]

Dear [Name]:

We would like to invite the [Board Name] to participate in a continuing study examining food, activity, and general health behaviours in Alberta youth. This research will investigate the nutrition, physical activity, and behavioural choices of students in grades seven through ten by using a web-based survey. Each student will receive brief individual feedback immediately upon completion of the computer-based survey. This web-based survey complements the Comprehensive School Health Model and new curriculum. Class group data will be provided to the teacher, with suggestions on how to incorporate the feedback into the grade-specific curriculum and relevant learning resources.

As you know, students in grades seven through ten experience many physiological and psychological milestones, including the adolescent growth spurt with rapid bone development, and increasing autonomy in food and activity choices. There is little information on the diet and physical activity behaviours of Alberta youth, however dietary surveys elsewhere indicate that teens consume insufficient amounts of energy, calcium, iron, and may have low levels of physical activity. Obesity is particularly concerning, as many overweight and obese children become obese adults, at risk for diabetes and heart disease. Thus the lifestyle behaviours of Alberta youth are of tremendous interest.

The web-based tool was developed by Dr. Rhona Hanning at the University of Waterloo, and has previously been used to survey over 1500 Alberta students. We are planning to survey 5000 additional Alberta students, creating the most comprehensive assessment of Alberta youth's diet and physical activity. Your board and schools within your board have been randomly selected to participate in this survey. Please find attached copies of the following: 1) a summary of the project with details on the design, objectives and measures to be used for this study, 2) the survey questions, 3) the information letter and consent form that will be sent to parents, 4) the information letter for the students, and 5) our ethics approval letter.

The following schools from within your board were selected: [School Names]. In the event an insufficient number of schools from your board can participate, we have selected back-up schools, which may be required in order to complete the research survey. These schools have been selected as back-up schools: [School Names].

This study has been reviewed by, and received ethics clearance from the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board at the University of Alberta. The research is funded by the Canadian Institutes of Health Research.

We would like an opportunity to speak with you to discuss our project and your school board's protocol for the approval of research projects. We appreciate the strain on school boards and schools at this time and do not wish to create more pressure. If there is anything we can do to make it easy for your schools to participate, please let us know. One of our staff will call you to determine your interest. In the meantime, if you have any questions, please call either Kate Calengor or Laura Kennedy at (780) 492-3700 or by e-mail at either calengor@ualberta.ca or lek1@ualberta.ca. We look forward to further collaboration with you on this project.

Sincerely,

Kate Calengor, PhD Student
Project Coordinator,
Dept of Agricultural, Food
& Nutritional Science
University of Alberta
Phone: 780-492-3700

Laura Kennedy, MSc Candidate
Project Coordinator,
Dept of Agricultural, Food
& Nutritional Science
University of Alberta
Phone: 780-492-3700

Linda McCargar, PhD, RD
Professor,
Dept of Agricultural, Food
& Nutritional Science
University of Alberta
Phone: 780-492-9287

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INFORMATION LETTER for Recruitment

[Date]

Dear [Name]:

We would like to invite [Authority Name] to participate in a continuing study examining food, activity, and general health behaviours in Alberta youth. This research will investigate the nutrition, physical activity, and behavioural choices of students in grades nine and ten [or grades seven and eight] by using a web-based survey. Each student will receive brief individual feedback immediately upon completion of the computer-based survey. This web-based survey complements the Comprehensive School Health Model and new curriculum. Class group data will be provided to the teacher, with suggestions on how to incorporate the feedback into the grade-specific curriculum and relevant learning resources.

As you know, teenagers experience many physiological and psychological milestones, including the adolescent growth spurt with rapid bone development, and increasing autonomy in food and activity choices. There is little information on the diet and physical activity behaviours of Alberta youth, however dietary surveys elsewhere indicate that teens consume insufficient amounts of energy, calcium, iron, and may have low levels of physical activity. Obesity is particularly concerning, as many overweight and obese children become obese adults, at risk for diabetes and heart disease. Thus the lifestyle behaviours of Alberta youth are of tremendous interest.

The web-based tool was developed by Dr. Rhona Hanning at the University of Waterloo, and has previously been used to survey over 1500 Alberta students. We are planning to survey 5000 additional Alberta students, creating the most comprehensive assessment of Alberta youth's diet and physical activity. Your school has been randomly selected to participate in this survey. Please find attached copies of the following: 1) a summary of the project with details on the design, objectives and measures to be used for this study, 2) the survey questions, 3) the information letter and consent form that will be sent to parents, 4) the information letter for the students, and 5) our ethics approval letter. Upon your approval of this research study, we would ask you to randomly select four classrooms (if possible) to participate in the nutrition and physical activity survey.

This study has been reviewed by, and received ethics clearance from the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board at the University of Alberta. The research is funded by the Canadian Institutes of Health Research.

We would like an opportunity to speak with you to discuss our project and your protocol for the approval of research projects. We appreciate the strain on schools at this time and do not wish to create more pressure. If there is anything we can do to make it easy for your school to participate, please let us know. One of our staff will call you to determine your interest. In the meantime, if you have any questions, please call either Kate Calengor or Laura Kennedy at (780) 492-3700 or by e-mail at either calengor@ualberta.ca or lek1@ualberta.ca. We look forward to further collaboration with you on this project.

Sincerely,

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Fax: 780.492.4265

INFORMATION LETTER for School Recruitment

[Date]

Dear [Name]:

The University of Alberta has the approval of your school board to invite [school name] to participate in a continuing study examining food, activity, and general health behaviours in Alberta youth. The research will investigate the nutrition, activity, and behavioural choices of students in grades nine and ten [or grades seven and eight] using a web-based survey. This web-based survey complements the Comprehensive School Health Model and new curriculum. Feedback from the survey will be available to the individual students, and teachers will receive group feedback and suggestions for incorporating the results into the curriculum, including relevant learning resources.

As you know, teenagers experience many physiological and psychological milestones, including the adolescent growth spurt with rapid bone development, and increasing autonomy in food and activity choices. There is little information on the diet and physical activity behaviours of Alberta youth, however dietary surveys elsewhere indicate that teens consume insufficient amounts of energy, calcium, iron, and may have low levels of physical activity. These have the potential to exert a strong deleterious impact on future health and increase the risk of chronic disease in later life. Through better understanding of the lifestyle patterns of Alberta youth, and variables that influence this pattern, targeted healthy eating and active living programs and strategies can be designed.

The web-based tool was developed by Dr. Rhona Hanning at the University of Waterloo, and has previously been used to survey over 1500 Alberta students. We are planning to survey 5000 additional Alberta students, creating the most comprehensive assessment of Alberta youth's nutrition and physical activity. Your school has been randomly selected to participate in this survey. Please find attached copies of the following: 1) a summary of the project with details on the design, objectives and measures to be used for this study, 2) the survey questions, 3) the information letter and consent form that will be sent to parents, 4) the information letter for the students, and 5) our ethics approval letter. Upon your approval of this research study, we would ask you to randomly select four classrooms (if possible) to participate in the nutrition and physical activity survey.

The research has been reviewed by and received ethics clearance from the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board at the University of Alberta. This research is funded by the Canadian Institutes of Health Research.

We would like an opportunity to speak with you to discuss this project and the possibility of your school's participation. We appreciate the strain on schools at this time and do not wish to create more pressure. If there is anything we can do to make it easy for your school to participate, please let us know. One of our staff will call you to determine your interest. In the meantime, if you have any questions, please call either Kate Calengor or Laura Kennedy at (780) 492-3700, or by email at either calengor@ualberta.ca or lek1@ualberta.ca. We look forward to further collaboration with you on this project.

Sincerely,

Kate Calengor, PhD Student	Laura Kennedy, MSc Candidate	Linda McCargar, PhD, RD
Project Coordinator,	Project Coordinator,	Professor,
Dept of Agricultural, Food	Dept of Agricultural, Food	Dept of Agricultural, Food
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WEB-SURVEY OF PHYSICAL ACTIVITY AND NUTRITION (WEB-SPAN)

The purpose of the project is to examine food behaviour, physical activity, and general health behaviour patterns in Alberta adolescents using an Internet-based 24-hour diet recall in conjunction with a food behaviour, and physical activity questionnaire.

WHY A SCHOOL SURVEY?

- Nutritional problems in youth have the potential to exert a deleterious impact on future health and increase the risk of chronic disease in later life.
- Results from small research studies in Canada and the U.S. suggest that children and adolescents are not consuming adequate amounts of meat and meat alternates and subsequently, iron and zinc intakes (especially in females) are low to marginal.
- The same studies suggest that young Canadians are not consuming the number of servings of milk and dairy products recommended by Canada's Food Guide to Healthy Eating. Hence, calcium intakes are not being met during a time of bone growth.
- Children and teens are also not meeting the minimum requirements for vegetables & fruit consumption and some related nutrients, like folate, may be low.
- Previous studies have not looked at some of the factors associated with youths' food consumption that may be important in designing relevant educational materials.
- School-based surveys are an effective way to collect information about this age group.

WHY USE THE INTERNET?

- The ability to provide immediate feedback to participants regarding their food behaviour.
- An interactive tool that is fun and easy for participants to use.
- The flexibility and universality of the Internet allows a large number of participants to complete the survey concurrently, in many different locations.

WHO IS INVOLVED IN THE PROJECT?

- The project is being conducted by Dr. Linda McCargar, Professor, Department of Agricultural, Food & Nutritional Sciences, of the University of Alberta. Dr. McCargar teaches and conducts research in the field of nutrition.
- Kate Calengor and Laura Kennedy are the project coordinators. Kate and Laura are graduate students in Nutrition at the University of Alberta. The project coordinators will be accessible by phone during the time period that each class is completing the Internet survey.
- Participants will come from grades seven through ten from schools across Alberta.
- The research survey is funded by the Canadian Institutes of Health Research.

WHAT IS INVOLVED FOR PARTICIPATING SCHOOLS?

- Teachers of students in grades seven through ten will be asked to facilitate the completion of the "Web-SPAN".
- Completing the survey requires approximately one class period and may be incorporated into a Mathematics, Health and Physical Education, or Computer Usage class.
- Surveys should only be done Tuesday through Friday to obtain weekday food intake. Students are asked to recall their previous day's food intake. If Monday is a holiday, then surveys should only be done Wednesday through Friday.
- Upon completing the initial survey at school, students may go back to the web site on another day, where the same set of questions about their eating habits will be available. This second portion of the project is optional.
- Teachers will receive group feedback and suggestions for incorporating the information into the grade-specific curriculum, and relevant learning resources.

CONSENT AND CONFIDENTIALITY MEASURES

- Information letters and consent forms will be provided to be sent home to parents.
- Parents must complete, sign and return a consent form before their child can participate in the survey.
- The survey is anonymous.
- All students will have a unique identification code and password; unauthorized users will not have access to the survey.

WHAT ARE THE BENEFITS TO THE STUDENTS AND SCHOOLS?

- School Feedback Report: Teachers will receive group feedback of their classrooms' data based on Canada's Food Guide to Healthy Eating, and suggestions for incorporating the results into the curriculum, including relevant learning resources. Feedback reports may be used by teachers to plan future lessons and to examine current students' eating and physical activity behaviours.

- Individual Feedback: Upon completing the food intake recall, students will receive information about their diets for that day, based on Canada's Food Guide to Healthy Eating. Students will develop a better understanding of their eating patterns, ways to improve their diets, and the benefits to healthy living.

FOR MORE INFORMATION, CONTACT:

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Letter and information package for teachers

[Date]

[Name/Address]

Dear [Name]:

Thank you for agreeing to participate in a "Web-Survey of Physical Activity and Nutrition (Web-SPAN)". The contribution that you and the students in your school will make is invaluable. The information gathered from this project may be used to develop nutrition and healthy lifestyle education programs targeting "risk" behaviours or at-risk populations. By identifying the factors that are associated with "risk" behaviours, we hope to indicate potential areas for preventive programs, and reduce the health and economic burdens associated with poor nutrition and low physical activity. Data may also be used to compare food consumption and activity patterns across populations, provinces and even internationally.

Preparing for the Survey:

This web-based survey complements the Comprehensive School Health Model and new curriculum and may be directly incorporated into Health, Science, Math, Physical Education, or Computer classes. The survey can be implemented during any class period.

If there are sufficient computer facilities, it would be most efficient for all of your students to complete the survey simultaneously. Otherwise students may complete the survey as an independent activity or however you deem appropriate. It is expected that students will require approximately one class period to complete the survey.

A package addressed to Kate Calengor or Laura Kennedy, and containing parental information letters and consent forms is included with this mailing. We are asking your school to either mail the letters and consent forms to all parents of potential participants, or have the students take the letter and consent form home to parents. You will also have received a package containing student information letters. Please distribute these to students in your class.

Participation in the study is voluntary, and the decision to participate is made by each student and his or her parents. If parents do not sign and return the consent forms to the teachers, students cannot participate in the survey.

Logins and passwords will be provided to you to access the survey once the signed consent forms have been returned to the University of Alberta. Randomly distribute these to each student who is participating, on the day of the survey. If you require more logins and passwords than are supplied, please contact either Kate Calengor or Laura Kennedy at (780) 492-3700. Please keep a record of the assigned logins and passwords on the sheet provided, noting those logins and passwords that were not assigned. To sustain anonymity, please do not include the students' names with their logins and passwords. If a student chooses to withdraw please note that on the same sheet.

One of our nutrition research assistants working on this project will be accessible by phone during the time that your class is completing the survey.

Completing the Survey

The survey is located at http://eatwell.igsol.com. The web site is best viewed using Internet Explorer, but any web browser will suffice.

The survey is available for teachers to visit before students input their food records.
Your login name is: s
Your password is: s

Students are able to complete the survey independently. It is important to note that:

- The survey is confidential and anonymous. Students' names are not on the survey. Every participant has a unique identification and password; only the researchers at the University of Alberta will see their answers. No one at the school will know students' answers.
- We would like to know what students ate ***yesterday***. We would like them to remember as much as possible.
- Surveys should only be done Tuesday through Friday to obtain weekday food intake. If Monday is a holiday, then surveys should only be done Wednesday through Friday.
- Surveys must be completed between the hours of 7 a.m. to 3 p.m. in order for technical support to be available.
- We have tried to include as many foods as possible, but we have not been able to include **every** food. Please ask the students to choose a food item that most closely resembles what he/she ate. If in doubt, please call the researcher on call during the survey period.
- The web site is available should students want to repeat the survey on a different day. This is of course optional, and would be done on the student's own time.
- Students may complete the survey only once each day. Twenty-four hours needs to lapse before students can input more data.

- Students should store their logins/password cards in a safe place. Students must remember their logins and passwords if they wish to return on another day to complete the survey.
- Participation in the survey is completely voluntary.

Directions for Accessing the Food Behaviour Questionnaire:

1. Open the Internet browser on your computer (Explorer or Netscape).
2. On the address line, enter the address: http://eatwell.igsol.com
3. Enter assigned login identification code.
4. Enter assigned password, hit the launch button.
5. The survey is open and ready to go. Follow the directions on the screen.

Your feedback regarding this survey is invaluable. We would appreciate your time in completing an online evaluation form using a login name and password that we will provide you on the day of the survey. However, if the online evaluation is not completed, a one-page question sheet will be faxed to you after the survey to obtain your feedback.

If you have any questions or concerns, please contact either Kate Calengor or Laura Kennedy at (780) 492-3700 or by email at either calengor@ualberta.ca or lek1@ualberta.ca. A nutrition research assistant involved in this project will be available by phone on the day(s) that your school completes the survey.

Thank you for your participation in the project, we look forward to sharing the results with you.

Sincerely,

Kate Calengor and Laura Kennedy, (780) 492-3700
Project Coordinators

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Faculty of Agriculture, Forestry, and Home Economics

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Parent Information Letter

Title of Research Project: Web-Survey of Physical Activity and Nutrition (Web-SPAN)

This letter describes research being conducted at your son or daughter's school by the University of Alberta (Department of Agricultural, Food & Nutritional Science). Dr. Linda McCargar is the researcher leading the study, and Kate Calengor and Laura Kennedy are the coordinators of the study. We would like to give you some information about the study to help you to decide if your son or daughter should be a part of it.

Your school board and principal have given us permission to conduct this research. This study has received ethics clearance from the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board at the University of Alberta.

Why is the study being done?

Teenagers are going through a time of physical and emotional changes. They are experiencing the final stages of the adolescent growth spurt with rapid bone development and increasing independence in food and activity behaviours. Previous surveys have shown that children and teens do not get enough food energy, calcium, iron, and are becoming less active. However, there is very little information on the diet and activity levels of Alberta youth.

Who are we looking for?

Teachers of eligible classrooms in your son or daughter's school are being invited to participate in this research. The study will involve 5000 grade seven through ten students throughout Alberta. If you are the parent/guardian of a student invited to take part in this research study, we hope you will agree to his or her participation in the research.

What does my son/daughter have to do?

A student will not be included in the study if a parent or guardian indicates that he or she does not want the student to participate, or if the student does not agree to take part. In order to participate in this survey, your son/daughter **must return a signed and completed consent form** to their teacher.

All of the students in participating classes will be invited to complete a nutrition and physical activity survey on the Internet during class time. This survey is designed to examine food and physical activity habits. We want to know what types of food your son/daughter eats and how they feel about certain foods. Upon completing the survey, your son or daughter will receive immediate feedback on their diet based on Canada's Food Guide to Healthy Eating. If your son or daughter wishes to revisit the web site on another day, the same set of questions about his/her food behaviour will be available.

Revisiting the survey is optional, and may be done on a computer at school, at home, or in the community.

It will take approximately one class period (~45 minutes) to learn about the web site and complete the on-line survey.

Why is the survey web-based?
In the past, other nutrition surveys have included only a small number of participants due to practical issues such as cost. The proposed research will use a web-based tool to deliver a nutrition and physical activity survey to a large number of Alberta children and adolescents. This will result in the most complete assessment of the diet and physical activity of Alberta youth to date.

What will the data be used for?
The information collected from the web-based survey will be used to increase our understanding of the nutrition and physical activity habits of adolescents in Alberta. It will also be used to make recommendations about the types of programs needed to improve the health of Alberta youth. All responses will be anonymous and research journal articles and reports will be written based on the group results obtained from this study; individual results will not be referred to in any publication, report, or presentation. We will compare our results to those of a similar study done in Alberta and Ontario. As well, if we re-administer this survey in the future, we will use the results from this study as a comparison for other data. Your son or daughter's involvement in this project does not obligate them in any way to participate in future surveys.

What if I change my mind about participation?
Being in the study is completely voluntary. Your son or daughter is free to refuse to answer any question(s). Being in the study does not pose any risks for your son or daughter. If you and your son or daughter agrees now to participate, but either of you change your mind later, either you or your son or daughter can withdraw at any time, up until the point when your son or daughter submits their survey on the Internet.

The final decision to participate in this study must be made by the individual student and his/her parent(s) or guardian(s). Your co-operation in permitting your son or daughter to take part in this research is greatly appreciated. However, there is no penalty of any kind if he/she does not participate. If you have any questions or concerns, please contact either Kate Calengor or Laura Kennedy at (780) 492-3700.

Will information about the student go back to the school?
Student names will not be included on the survey; the survey is anonymous. Individual student responses will be kept completely confidential and no individual results will be made available to school or other personnel. Each student will have a unique identification and password. The web site will be password protected so that unauthorized users will be unable to gain access.

Only the researchers at the University of Alberta will have access to the locked computer files on which we will keep your information. These computers are located in locked offices. The data will be permanently stored on CD in electronic form, which will be held in locked offices at the University of Alberta. Funders and the Advisory Committee will not have access to this information.

Identification codes, not participant names, will be used in the data analysis. All data are published in group form so that it will not be possible to determine the responses from any individual student. The teacher will have access to the group results and we will provide feedback to their class. This ensures that the study can support and enhance the curriculum.

Who is funding this project?
This research is funded by the Canadian Institutes of Health Research.

How do I include my son/daughter in the project?
If you would like to include your son or daughter in this research project, please complete and sign the attached consent form and have your son/daughter return it to their teacher as soon as possible.

If we do not receive a signed and completed consent form from you, your son/daughter will not be able to participate in the survey.

Sincerely,

Kate Calengor, PhD Student Project Coordinator, Dept of Agricultural, Food & Nutritional Science University of Alberta Phone: 780-492-3700	Laura Kennedy, MSc Candidate Project Coordinator, Dept of Agricultural, Food & Nutritional Science University of Alberta Phone: 780-492-3700	Linda McCargar, PhD, RD Professor, Dept of Agricultural, Food & Nutritional Science University of Alberta Phone: 780-492-9287

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Student Information Letter (Grades Seven and Eight)

This letter is a request for your help in a study we are doing at the University of Alberta. We would like to give you some information about the study and what you need to do to take part.

Why is the study being done?
We want to collect information on what pre-teens and teenagers in Alberta are eating, how active they are and other factors that influence nutrition and physical activity.

What do I have to do?
If you wish to participate, your parents and/or guardians have to sign and complete the study consent form. After the signed consent form is given to your teacher, he/she will give you a login and password. This login and password will let you sign in to our web survey. We will first ask you to complete the survey on the Internet at school.

What if I want to quit being in the study?
Being in the study is completely up to you. You are free to say you don't want to answer any question. You can also decide to stop all together at any time before you submit your survey on the Internet. If you have any questions about the study, please contact Laura Kennedy at (780) 492-3700 or lek1@ualberta.ca.

Will information about me go back to my school?
Your name will not be on the survey. All the information that you give to the research group will be kept private. No one at your school will know your answers. Your classroom's average group results will be provided to your teacher.

The final decision to be in this study must be made by you and your parents. We hope you enjoy this survey – and learn from the information you get from the survey. However, there are no consequences any kind if you do not participate.

Sincerely,

Laura Kennedy, MSc Candidate Project Coordinator, Dept of Agricultural, Food & Nutritional Science University of Alberta Phone: 780-492-3700	Linda McCargar, PhD, RD Professor, Dept of Agricultural, Food & Nutritional Science University of Alberta Phone: 780-492-9287

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Student Information Letter (Grades Nine and Ten)

This letter is a request for your help in a study we are carrying out at the University Alberta. Dr. Linda McCargar is the researcher leading the study. Kate Calengor is the coordinator of the study. We would like to give you some information about the study and what you need to do to be a part of it.

Why is the study being done and what will the data be used for?
There is only a little information available on the diet and physical activity of Alberta teenagers. Your diet and activity can affect your growth and health. Students throughout Alberta, in grades nine and ten, will be asked to participate in this project. This will provide us with a better understanding of eating patterns of adolescents and things that influence these patterns. We hope to use this information to make recommendations on how to improve the health of teenagers. As well, since a similar project was conducted in Alberta and Ontario (investigators: Dr. Linda McCargar and Dr. Rhona Hanning), the results obtained from this survey will be compared to the results from other Alberta and Ontario students to see if there is a difference in how teenagers are eating. As well, if we re-create this survey in the future, we will use the results from this study as a comparison for other data. Your involvement in this project does not require that you participate in future surveys.

Who are we looking for?
Teachers of eligible classrooms in your school are being invited to participate in the research. If you are a student in one of these classrooms, we would welcome your help with the research.

What do I have to do?
If you wish to participate, your parents and/or guardians have to sign and complete the consent form that was delivered to them, either by you or the school. This form needs to be given to your teacher before you can complete the survey. Your teacher will assign you a login and password that will allow you to sign in to our web survey. We will ask you to complete the survey on the Internet at school. This survey is designed to examine food and physical activity habits. We want to know what types of food you eat and how you feel about certain foods. It should require approximately one period (~45 minutes) of class time. If you wish to complete the survey again on another day, you can. This is completely optional.

Why is the survey web-based?
A web-based survey was selected so that we could have a very large number of students from Alberta fill out the survey. This will result in the biggest survey of adolescent diet and physical activity to date.

What if I want to quit being in the study?
Being in the study is completely voluntary. You are free to say you don't want to answer any question. You can also decide to stop all together at any time before you submit your survey on the Internet. Being in the study does not have any risks for you. If you have any questions about the study, please contact Kate Calengor at (780) 492-3700 or calengor@ualberta.ca.

We have received permission from the school board and your school principal to conduct this research. This study has been reviewed by, and received ethics clearance from the Faculty of Agriculture, Forestry, and Home Economics Research Ethics Board at the University of Alberta.

Will information about me go back to my school?
The survey is anonymous. This means that your name will not be on the survey. You will have a unique identification and password. The web site will be password protected so that unauthorized users will be unable to gain access. All the information that you give to the research group will be kept private. We will not give information about your answers to any other group, including your school. No one at your school will know your answers. When we report survey results, no individuals will be identified. Only the researchers at the University of Alberta will have access to the locked computer files on which we will keep your information. These computers are located in locked offices. Your teacher will receive group averages for your class as a whole.

The final decision to participate in this study must be made by you and your parents. We hope you enjoy participating in this survey – and learn from the information on your diet that you receive at the end of the survey based on Canada's Food Guide to Healthy Eating. However, there are no consequences of any kind if you do not participate.

Sincerely,

Kate Calengor, PhD Student Project Coordinator, Dept of Agricultural, Food & Nutritional Science University of Alberta Phone: 780-492-3700	Linda McCargar, PhD, RD Professor, Dept of Agricultural, Food & Nutritional Science University of Alberta Phone: 780-492-9287

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CONSENT FORM

Please COMPLETE, sign, date and return this form to your son/daughter's teacher

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Consent Form

(Please COMPLETE, sign, date and return this form to your son/daughter's teacher)

Title of Research Project: Web-Survey of Physical Activity and Nutrition (Web-SPAN)

Investigators:

Kate Calengor, PhD Student	Laura Kennedy, MSc Candidate	Linda McCargar, PhD, RD
Project Coordinator,	Project Coordinator,	Professor,
Dept of Agricultural, Food & Nutritional Science	Dept of Agricultural, Food & Nutritional Science	Dept of Agricultural, Food & Nutritional Science
University of Alberta	University of Alberta	University of Alberta
Phone: 780-492-3700	Phone: 780-492-3700	Phone: 780-492-9287

Consent: Please circle your answers:

Do you understand that you have been asked to include your son or daughter in a nutrition and physical activity research study that will require approximately 45 minutes of class time?

Yes **No**

Have you read and received a copy of the attached Information Letter?

Yes **No**

Do you understand that there are no risks involved in including your son or daughter in this research study?

Yes **No**

Do you understand that your son or daughter can quit taking part in this study at any time up until the point he or she submits their survey on the Internet? Neither you nor your child has to say why and it will not affect the benefits your son or daughter will receive.

Yes **No**

Was confidentiality adequately explained to you in the information sheet?

Yes **No**

Do you understand who will be able to access the nutrition information collected from this study?

Yes **No**

Do you understand that the information obtained from this project (group results) may be compared to results obtained from a similar survey conducted in Alberta and Ontario and that the information may also be compared to results from future surveys?

Yes **No**

WILL YOU CONSENT TO HAVING YOUR SON OR DAUGHTER TAKE PART IN THIS RESEARCH STUDY?

Yes **No**

Please sign and date below:

Date: ______________________________

Signature of parent/guardian:______________________________
Name of parent/guardian:___________________________________

As per research guidelines, the anonymous data will be stored for seven years following time of collection. There will be no paper copies of the data. All data will be stored electronically (on CD) and kept in locked offices on password-protected computers

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Web-SPAN Assent (part of web-survey)

This questionnaire is designed to examine your food habits and those of other students your age. We want to know what sorts of things you eat, what you like to eat, and how you feel about certain foods. We know that not everyone feels the same way, or eats the same things, but we are very interested in your answers to the following questions.

The questionnaire is strictly confidential. No one, except the researchers, will see your finished questionnaire, so please be as honest as you can. If there is a question that you don't know how to answer or don't want to answer, that's okay, just go on to the next one.

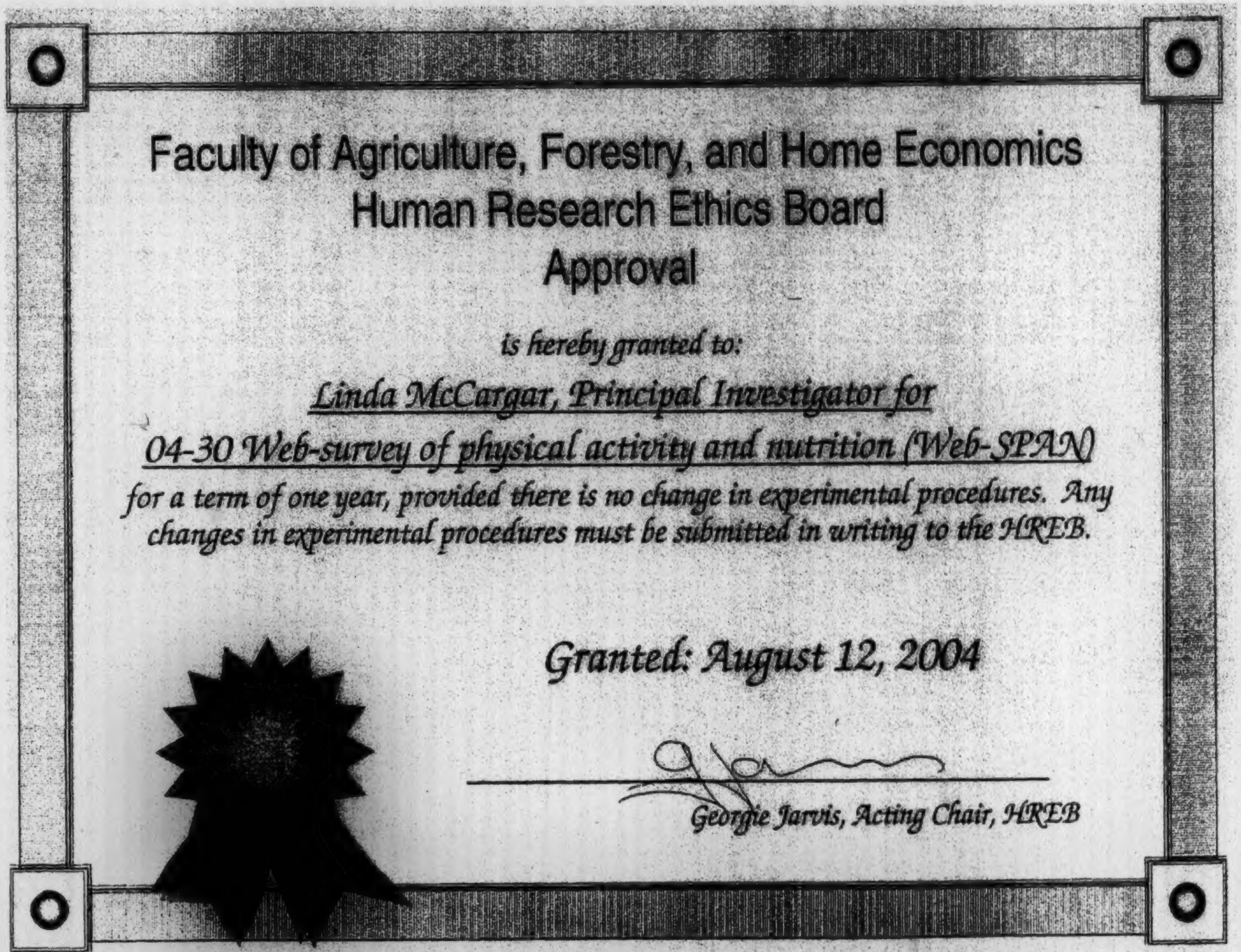
Thanks for helping us with this very valuable research!

Do you agree to participate in this survey?

Yes **No**

*****Note: If student did not choose "yes", they could not proceed with the survey***

Appendix I: Ethical Approval – Web-SPAN



Faculty of Agriculture, Forestry, and Home Economics
Human Research Ethics Board
Approval

is hereby granted to:

Linda McCargar, Principal Investigator for

04-30 Web-survey of physical activity and nutrition (Web-SPAN)

for a term of one year, provided there is no change in experimental procedures. Any changes in experimental procedures must be submitted in writing to the HREB.

Granted: August 12, 2004

Georgie Jarvis, Acting Chair, HREB